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Land Use Changes: Methodological Approach to Understand the Interactions Nature / Society in Coastal Areas (Alencoast)

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Space Applications Institute

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FORWARD

The report being presented now is the result of a study on *Land Use Change*: *Methodological Approach to Understand the Interactions Nature / Society in Coastal Areas*. This study has been carried out within the framework of a research contract funded by the Directorate General Joint Research Centre, Agriculture and Regional Information Systems, Unit Space Applications Institute in which we specially recognise the enthusiastic support of the technical responsible, Mrs. Vanda Perdigão.

A feature of the work conducted during the eight months has been the important collaboration of the Centro Nacional de Informação Geográfica, particularly Mr. João Reis Machado, who made possible the use of statistical information with a high level of spatial resolution, which was kindly authorised by the Instituto Nacional de Estatística.

A methodological effort should be highlighted, specifically in terms of the difficulties of compatibility of the statistical and digital data. The existence or non-existence of databases (statistical, from official bodies and available on a digital support) determines the different usage of analysis instruments. With regard to the use of GIS, it should be stressed that this study was only possible due to the existence of digitised data for Portugal, in the Corine and Lacoast programmes.

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SUMMARY

Title

Land Use Change: Methodological Approach to Understanding Nature / Society Interactions in Coastal Areas (Alencoast)

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Scientific Objectives

The **main objective** was to design an integrated methodology in order to understand land use changes in coastal areas, and to propose a comprehensive analysis, which:

a) Examines the influence of socio-economic and biophysical driving forces on land use changes,

b) Identifies the various actors playing in the territory and allows for the understanding of how their behaviour and strategies explain land use changes, and

c) Contributes to the development of the application of methodological tools, such as Geographic Information Systems, for an integrated analysis with an effort to achieve compatibility of various kinds of data.

The aim of this project was to design a methodology that allows the understanding of land use changes in coastal areas, and this, through an analysis of the impact of human and biophysical dynamics. The cross between human and biophysical factors, which is at the root of land use, contributes to the understanding of the complexity of processes of change.

In fact, the analysis of the processes of change in coastal areas and their relation with external driving forces, such as policies, was made possible only by considering regional dynamics.

The research project was based on a cross-disciplinary approach to understanding change in coastal areas, integrating both socio-economic and biophysical dimensions. The study examines societal driving forces – political, economic, institutional and social - that influence the development of coastal areas and modify the landscape by changing landforms, land use and land cover.

The research project has benefited from the results of other projects carried out by the team focused on the Alentejo region as well. The dynamics identified in this region have an impact on land use changes in the coastal area. As such, one of the major results was the understanding of the influence of these same dynamics in those processes of change.

The methodology is designed to analyse the problem progressively by levels – national, regional and local - and by using different techniques according to the specific characteristics of the aspects, which are the objects of analysis.

One of the main challenges of the study was to design a methodology in order to combine information from different sources and of different nature and scales into the system of analysis.

Description of the work carried out

An important feature of the work conducted in the project is the objective of designing an integrated methodology. Hence, all the tasks involved a special concern for integrating the various kinds of data and levels of analysis, and the study progressed from the most general to the most specific spatial level.

Phases a Tasks defined in the proposed technical content

1. **Data settlement and compatibility**
   - A survey of the available policy and scientific literature on the state of the development and the environment of - the Alentejo, in particular the Coastal Alentejo.
   - Selection of statistical data on the demographic, socio-economic, institutional dimensions.
   - Compatibility of statistical data and Corine/Lacoast information.
2. **Exploratory analysis directed by the research questions**
   - Characterisation of the natural and socio-economic framework.
   - Identification of the different types of land use changes for two periods.
   - Intensive primary data treatment, and compatibility between Lacoast information and socio-economic data.
   - In depth analysis of the interrelationships between land use changes, population, development and the environment.
3. **Discussion of results**
   - Assessment of the options for economic and social development and the sustainable use of coastal resources.
4. **Report / Presentation of an integrated methodology**

The first five months of the project were spent gathering the necessary data and assuring the comparability of the various kinds of information. It was, therefore, necessary to collect data on the land cover and the socio-economic traits of the population of Alentejo coastal.

All of these data were gathered for diverse territorial scales in such a way to fulfil one of the most important steps of the proposed methodology. The land cover analysis was focused on a 10 km large strip along the coastline.

During the first five months of the project, an exploratory analysis directed by the research questions was also carried out.

The last phase of the project was the full development of GIS analysis capabilities and, therefore, the accomplishment of the main objective: to design a methodology which aims to understand the processes of land use changes in coastal areas through the analysis of the impact of human and biophysical dynamics.

The main activities were connected to data processing and analysis, specifically, measurement of land cover changes and analysis of spatial-temporal relationships between these changes and the socio-economic and institutional dimensions. The main land cover dynamics and societal driving forces were, therefore, identified.

In this phase, the benefits and problems related to this kind of methodology were also discussed; constituting a chapter in the final report that was written during the final months of the project. The structure of this final report reflects two kinds of approach: one, the presentation of the methodological scheme, and the other, the application of that methodology to the coastal area of the Alentejo.

INTRODUCTION

This publication is based on the Final Report on the work carried out in the project, Land Use Change: Methodological Approach to Understanding the Nature / Society Interactions in Coastal Areas (Alencoast).

The main objective of the project was to design an integrated methodology in order to understand land use changes in coastal areas, and to propose a comprehensive analysis, which:

- Examines the influence of socio-economic and biophysical driving forces on land use changes.
- Identifies the various actors playing in the territory and allows for the understanding of how their behaviour and strategies explain land use changes.
- Develop the application of methodological tools, such as Geographic Information Systems, for an integrated analysis, with an effort to achieve compatibility of various kinds of data.

The research was based on a cross-disciplinary approach to understanding change in coastal areas, integrating both socio-economic and biophysical dimensions. The study examined the societal driving forces – political, economic, institutional and social - that influence the development of coastal areas and modify the landscape by changing land forms, land use and land cover. The Lacoast database (Land Cover changes on European coastal zones) provided information on Land Cover changes for a period of around 12 years.

Four main points have structured this report: a presentation of the methodology to understand changes in coastal areas, an application of the methodology to the case of coastal Alentejo, an analysis of the main processes of land use and socio-economic change and a final chapter with the discussion of the results achieved. The report also presents a collection of several charts and maps that are in the end of each chapter.

In the first chapter, the framework proposed was built to develop a methodological approach, which integrates socio-economic and biophysical dimensions of land use change in coastal areas. The specificity of the research on coastal areas embodies a special focus, given the increasing importance that they have assumed in the global framework of present economic development. The number and diversity of agents searching for space in coastal areas calls for an integrated management in such a way as to minimise the negative impact of the increasing number of activities.

The second chapter of this report refers to the Alentejo region and includes an analysis of the regional framework and the coastal zone. In fact, the analysis of the processes of change in the coastal areas and their relation to external driving forces, such as policies, is only possible by considering regional dynamics. However, to understand the complexity of the processes of change and the link between human and biophysical factors, it is important to develop a deeper analysis of local case studies.

In the third chapter, the land cover and the socio-economic dynamics identified in the studied region were presented. The construction of a typology of these dynamics was a crucial step towards understanding the processes of change.

The Discussion debates the main results obtained in the research, revealing the issues and constraints in the accomplishment of the objectives of this project. The association of different scientific approaches and levels of analysis was a way of accomplishing an integrated analysis. However, this multi-disciplinary integration cannot be faced as a superposition or assembling of diverse empirical approaches. It represents a link among various scientific domains and levels of spatial or time analysis.

Time analysis is a significant element of the methodological design. If this study aims to understand the processes of land use change, it is required to analyse various periods, besides the study of different rhythms or cycles of the phenomena. The accurate study of these different moments must contemplate the changes of the biophysical and social frameworks. Land use change is, therefore, the reflection of the practices of the various agents conditioned by the changes in the global framework of each period.

Nevertheless, we regret that this project did not contemplate the possibility to integrate, in the analysis, the individual responses to and expectations of broad land use changes.

1. A METHODOLOGY TO UNDERSTAND CHANGES IN COASTAL AREAS

1.1. Conceptual Framework

1.1.1. Problems of Terminology

The importance of coastal areas as an object of study has emerged in recent times. This is due to the increasing complexity of the activities that are present in those regions, that is to say the complexity of the processes of change present in those areas. Moreover, various scientific research domains contemplate this complexity. Therefore, it is of great importance to fix the limits of what is considered as *Coastal Areas.*

For the physical researchers the coastal areas are related to the influence of the presence of the sea. This conception of coastal areas frames a region, with variations in large of its limits, that includes the coastal plain, the coastal cliff and the coastal plateau. In the immersed area the limits could also include the continental shelves. Therefore, it is a demarcation clearly related to the influence (present or past) of the sea in the shaping of these areas.

In the context of this study the coastal areas are considered as those regions, located near the sea, where one can observe **rapid** and **intense** socio-economic and environmental changes. These changes call for **fast** and **appropriate** policy responses, as well as act as important driving forces over hinterland regions.

They can be considered as *"Hot Spot"* areas in the sense that they are one of the most dynamic and intricate areas of the planet.

This complexity involves significant processes of population dynamics, which are expressed in population growth, demographic stress and rapid and intense migrations (hinterland-coast, rural areas-coastal areas).

Also the importance of these areas involves complex Land use and Land cover (LUCC) dynamics. These dynamics are shaped by different factors, where we can see the importance of physical drivers (such as geomorphologic, extreme events and natural hazards) and social drivers (population dynamics, industrialisation, external market forces, cultural and life style patterns and policy regulations). They are reflected by:

- Changes in spatial distribution of forests, agricultural and urban areas;
- Changes in environmental functions;
- Changes in performance and management expressed by intensive/extensive use of land that reflects also the land tenure / ownership structures.

This type of approach to coastal areas reflects a distinctive way of understanding these areas. In addition to the links studied by physical researchers, which give more importance to land-ocean interactions, this type of approach is emerging in studies related to coast-hinterland interactions.

Thus, these studies constitute a relatively new topic of research within the Land use and Land cover Change scientific network. The approach should be the analysis of different case studies that should provide methodological tools to the diverse users of the land. Therefore it is very important to develop methodological approaches to the study of land use change in coastal areas.

These methodological approaches must apply to the capacity of remote sensing and geographical information systems techniques in order to develop and support research in those areas.

1.1.2. Studies in Land use change

Land use change is a key research and policy issue, which provides the theme for significant amounts of cross-disciplinary research in Europe. Despite the existence of a large number of national and trans-European research programmes aimed at assessing the sustainability of land use systems, there are few programmes with the explicit task of developing integrated methodologies. Thus, the need to provide a forum for the debate and assessment of research methodologies as a means of developing convergence between disciplines.

Given the growing and often conflicting pressures on land use systems, this area of research has been identified as a major point of focus for national and international policies. Key policy statements in this area have been made in a number of framework documents, as identified below.

Within Europe:

- Towards Sustainability: A European Community Programme of Policy and Action in relation to the Environment and Sustainable Development, EEC, COM(92) vol. 11, 27 March 1992;

- The Cork Declaration: A Living Countryside. European Conference on Rural Development "Rural Europe - Future Perspectives", Cork 7-9 November 1996.
- Agenda 21.
- Grounds for Choices. Four perspectives for the rural areas in the European Community. Netherlands Scientific Council for Government Policy. Vol. 42, 1992.

Internationally:

- Land Use and Land Cover Change (LUCC): the Science and Research Plan. IGBP Report No. 35, and IHDP Report No. 7, 1995.
- IPCC. Climate Change 1995: Impacts, Adaptations and Mitigation of Climate Change. Scientific-Technical Analyses. Working Group II, 1996.
- The UN-CD Framework Convention on Climate Change.
- The Biodiversity convention.
- A sustainable world. Defining and measuring sustainable development. TRZYNA, T. 1995 (IUCN/ICEPP).
- Strategies for National Sustainable Development. A handbook for their planning and implementation. CAREW-REID, J.; PRESCOTT-ALLEN, R.; BASS, S.; DALAL-CLAYTON, B. 1994 (IUCN/IIED).

Generally speaking, the effects of land use change on global change are still little known in much the same way as the factors, which are behind those processes, are not fully understood. There are difficulties in defining methods of intervention in the regions and in obtaining support instruments for decision making which are fundamental to managing, understanding, monitoring and assessing the (environmental and social) changes resulting from modifications in land use.

Therefore, the land use study involves both the manner in which the biophysical attributes of the land are manipulated and the purpose for which the land is used: forestry, parks, livestock herding, urban areas, suburbia, and farmlands (IGBP Report No. 35:20). The chosen classes denote intent or purpose of use, so knowing this purpose or intent is a way of understanding the trends in change.

The demand for improved knowledge of environmental processes and of the impact of policy on their dynamics will likely increase, as population pressures on food supplies and natural resources mount and the publicly-held perception of preserving environmental diversity and amenity strengthens.

The nature and distribution of human activities on coastal areas result from the action of a range of driving forces – demographic, institutional, commercial and market, cultural and technological. The impact of these forces explains the land use changes and the way in which the coastal resources are affected.

Some of the most profound changes in the landscape have arisen from direct decisions by man concerning land use, and these have affected both the quality of environmental resources, such as soils and water, and the sustainability of food production. Land use decisions are based on opportunities and constraints affected by both biophysical and socio-economic drivers. Predicting future land use change requires methodologies that integrate understanding of the processes affected by these drivers. Because the dynamics of land use and land cover can have biophysical, social, economic or ecological drivers, we must use a cross-disciplinary approach to analyse the various problems. Although the work departs from the disciplinary perspective of traditional land use studies, it must maintain the specificity of each science.

Aside from more integrative approaches to human / environmental syntheses, which must provide for a better understanding of biophysical and social driving forces, we need to push further from land cover to land use in order that we understand the processes more than the patterns of occupation of a territory.

Another issue is related to the importance of developing coastal – hinterland integrative models to the land use change analysis. These models are very important in supporting land use change scenarios and are therefore of great use to rapid policy responses that inter-link socio-economic and environmental changes.

1.1.3. Coastal Areas as an Object of Study

The multiple uses of coastal areas constitute excessive and competing demands on limited resources. There are basically two types of conflicts that can be observed:

a) Those between the natural and socio-economic systems operating, or in other words between natural environment and human activities. For example, it is very important to study the impact of the introduction of new activities, such as tourism, on the environment. The increasing pressure to urbanise coastal areas could transform,

in a first stage, a natural region into a chaotic area. Likewise the increasing construction of new highways in those regions has an impact, locally and regionally, and not only on the natural environment, that is far from totally known. However, in a second stage, the disturbance, or even degradation, of the environmental conditions will be a significant constraint to the development of the introduced socio-economic activities.

b) Those within the socio-economic system itself, in terms of conflicts among the diverse users of the limited natural resources available. For example, a new activity such as tourism will have an impact over the population in terms of changing the structure of labour force, introducing elements of conflict or competitiveness between the diverse agents of change.

Nowadays, coastal areas are under a demographic pressure due to the population concentration trends verified in these areas. Observation that coastal resources are limited in supply, and that their continued "healthy" existence is crucial to the functioning of coastal areas, suggest the three research questions:

- How do societal driving forces affect coastal resources? Which are the key drivers that will generate or foreclose actions in the future?
- What are the policies, economic and environmental, which are supportive of, and which constrain sustainable development?
- How might changes under alternative scenarios of economic development and urbanisation affect coastal landforms, land use and land cover?

Another important issue is related to the diversity of coastal areas. Besides the geographical diversity (the tropical mangrove and its dynamics and problems are clearly distinct from the problems and dynamics of the coastal or sandy shores of temperate zones) it is important to take into account the diversity introduced by human activities. In the same geographical framework, the pressure generated by a major urban centre is quite different from the pressures associated to tourism settlements. Also industry has an impact different from activities such as agriculture, fisheries or quarrying. The combination of these diversities leads to different types of coastal areas.

1.1.4. Socialising the GIS

Since the inclusion of an institutional dimension is one of the bets of this methodology, it must be mentioned that, as Arminda Reis (1993) states, GIS facilitate the thematic representation of the "results of institutional policies and criteria". Hence, conditions to carry out analyses involving data originating from the most varied sources are created.

One of the main driving factors of this strategy of integrating data in a GIS is the institutional perspective. It is essentially in order to address this perspective that the necessity to survey the various regional levels, insofar as the options of structural character are at the root of some of the most important transformations of the territory, and these assume, above all, a regional nature.

Hence, there is often the need to analyse the institutional perspective at a regional scale, in order to understand the delays that may exist between the processes of land use change / cover and the socio-economic dynamics.

The irregularity of spatial distribution of several territorial management measures may be at the root of the processes of change that in turn, influence or may be influenced by, socio-economic factors. At the level of GIS, this problem is dealt with by systematically surveying the various regional scales, in such a way as to find an adequate answer to the land occupation transformations.

These hypotheses have contributed towards the understanding of land occupation changes, applying the notion of "socialising the pixel[1]" (Geoghegan, 1998), that results from this cross between biophysical and socio-economic variables, that however, encounter various obstacles in terms of reading.

The relationship between the land use/occupation and the socio-economic data are rarely direct ("linking people and pixels" Entwisle, 1998). Nevertheless, the association is essential to this methodology in that it allows us, at a certain regional scale to make an initial reading, supported by the processes of change.

The institutional dimension will legitimise the dynamics of the analysis scales, thus helping to increase knowledge of the region.

The socialisation of the GIS involves the creation of a local analysis scale, where the GIS supports the structuring

[1] Here, the notion of a pixel associated with biophysical data arises again.

of the investigations, making it possible to put forward explanations for land use changes.

At first analysis, there is a whole set of relations that reveal the potential of "socialising the pixel", which one could use to support assertions that justify land use / occupation changes. For example, there is the growth of the resident population in the parish of Sines and the increase in urban area; the increase of employment in the secondary sector in the area of Sines and the growth of industrial areas in its environs.

It is also possible to make a reverse reading of this relationship, such as, data of a socio-economic character may reflect at a given moment a certain transformation in land occupation, a fact that consequently validates the dynamics of land use. This is what Geoghegan (1998) calls "pixelising the social". For instance, there is a practically direct relation between the land use changes, particularly through the processes of changes with implications on the dynamics of artificialised spaces, and the data of the grid (1 km^2) relative to buildings. Hence, this type of data not only allows for the confirmation of changes detected, but also helps provide an alternative reading, since it deals with data that is temporally deferred in relation to the time of land use.

1.2. Methodological approach

Both the scientific community and the policy makers perceive the convergence between economic viability and environmental protection as being an important step towards land use sustainability. However, the accomplishment of this perception and its development into a coherent research strategy is not easy; to date the scientific community has yet to provide a robust framework and suite of methodologies within which such strategies can be developed. Mainstream research has adopted approaches only relevant to individual disciplines and the difference in methodologies between disciplines has tended to preclude effective integration of approaches within single research projects.

Integration underpins the success of the policy-making process, as well as aiding the definition of research priorities relevant to policy decisions. Furthermore, this process needs to involve the stakeholders operating within the landscape: for example, landowners and agricultural managers, local and national regulators, planners and governments, local and national pressure groups, the private and entrepreneurial sector, and the wider public.

The scientific basis of this perspective is the belief that integrating physical and socio-economic approaches in the study of land resources and land use systems represents a conceptually correct means of addressing the issue of unifying economic and environmental sustainability.

For example, the social sciences still lack an appropriate conceptual framework for the understanding of complex interactions between society and the environment. Moreover, the majority of studies tend to concentrate on the effect and impact of man's actions on the environment, dedicating little attention to the consequences of those changes on human activity.

Studies on the role which humanity plays in global change are often carried out within the concept of an *analysis of the human dimension*. Thus, they loose the systemic perspective which considers society as a sub-system interacting with the natural sub-system within the far-reaching and integrated framework which is the global change system (Mesarovic *et al.*, 1996).

The use of this systemic perspective allows the complexity of the interactions defined by the social and natural systems to be incorporated in the analysis and obliges the development of a different view on the relationship of these two systems. This view shows that they interact through logic of reflexivity. In other words, the social systems are changed at the same time as they modify the natural system, *i.e.* the impact of human activity on the environment and the consequences of the latter's deterioration on human activity cannot be considered separately since they are related in real time.

The multi-disciplinary approach

It is assumed that the reactions of the different land users will largely determine the impact of the policies in terms of constraints and opportunities for development. This conceptual approach should take into consideration the external driving forces. In other words, the general framework of measures which direct and rule society's intervention in nature. Therefore, land use study "...involves both the manner in which the biophysical attributes of the land are manipulated and the intent underlying that manipulation - the purpose for which the land is used..." (Turner *et al.*, 1995).

Approaches toward the assessment of environmental and policy change impacts on the sustainability of land use systems in Europe have traditionally followed two tendencies:

1. Disciplinary approaches', developed from the perspective of a single discipline and using terms of reference and techniques most acceptable to that discipline, often with only a limited consideration of broader influences;

2. 'Generic approaches', developed primarily within the impacts' community, which attempt to provide forecasts of likely scenarios that encompass the dynamics of complex systems.

Whilst 'disciplinary' approaches provide scientifically exact methodologies for constructing robust frameworks within which assessments of sustainability and policy impacts may be carried out, they often underestimate the range of variability associated with complex systems. Conversely, the 'generic' approaches attempt to encompass the breadth of complex systems, yet they often lack the robust methodologies and process descriptions required to accurately forecast future changes, often failing even to predict the current observed variability.

The *multi-disciplinary approach* departs significantly from existing research addressing similar issues. Existing approaches distinguish between the biophysical and economic (Carter *et al.*, 1994), reflecting both the disciplinary perspective of researchers and the difficulty in attracting funding from traditional sources when addressing cross-disciplinary research. The unified approach outlined will more adequately address sustainability in terms of 'cost-benefit' analysis by developing a common baseline for both the economic and the physical attributes of the landscape. Furthermore, this baseline approach will allow a numerical appraisal of the concept of sustainability, which traditionally has been difficult to quantify (Pearce, 1993). In addition, efforts will be made to incorporate social science research and stakeholder inputs, which cannot readily be translated into model form.

The sociological and political area

Analysis of sociological and political structures can help to identify the decisive elements that influence the decision-making process as it affects land use change. For example, constraints, which depend on agricultural structures, may be at the level of education or the level of regional agricultural consultancy.

One of the most important elements is the agricultural system created by the Common Agricultural Policy (CAP). The CAP, with its market regulations, has until now dominated production and markets for the most important agricultural products. The market regulations have provided hitherto specified criteria, which stimulated maximisation of production but provided no inducements for farmers to create new marketing strategies for their products. The intervention system has offered farmers (until the reform of the CAP) an almost unlimited guarantee to produce. Farmers were not compelled to ask if there is a demand for their products at all. However, diversification strategies especially require this kind of ability.

The economic area

The structural economic framework in which land use is carried out often limits the chances of alterations. An EU-policy has, therefore, to conceive several different economic constraints to promote a sustainable land use: the incomes of farmers, the investments and consequently the economic risk, the rural trade (which is an important link between agricultural producers and industrial processors). An economic analysis has to indicate where the crucial points in the chain of agricultural production, processing and marketing are and how the representatives can overcome emerging problems. What have been the economic restrictions resulting from CAP? What are the economic effects of an ecologically oriented programme?

The ecological area

Because of its policy of intensification, the CAP has resulted in several ecological problems, and the removal of these damages creates costs for society as a whole. We can assume that the restrictions concerning agricultural production will increase. At the same time, there are regions where the dominant trend is extensification; sometimes resulting in abandonment, but always leading to changes in the cultural landscape and human-created balance. Therefore, projects, which are based on the production and intensive use of pesticides and mineral fertiliser, will not have a chance in the future. For an understanding of this complex issue the following questions are important: What are the ecological damages or benefits of a process of land use change? Which impacts modify the quality of environmental resources (water, air, and soil)? What are the impacts on landscape development and landscape quality?

The bio-physical area

Of the physical global environmental change processes, land degradation and climate change will probably have the most significant impacts on future land use, although the desire to preserve environmental quality more broadly will also be important. Current land degradation processes include:

- acidification (due to acid deposition and drainage of acid sulphate soils);
- peat wastage (due to oxidation and erosion);
- salinisation;
- soil erosion (by water and wind);

- desertification/abandonment;
- deterioration in soil quality (organic carbon contents, structure);
- and contamination (of industrial sites);
- radionuclide contamination (e.g. Chernobyl);
- over abstraction of groundwater.

Other pollution influences on land use include nitrogen deposition and CO_2 fertilisation (Sombroek and Gommes, 1997), and climate change will have widespread impacts (IPCC, 1995). It should be recognised, however, that global change processes are intimately linked with human and policy influences. It seems certain that the world is already committed to climate change (IPCC, 1995), and so the capacity of people, and governments, to adapt to their changing environment is likely to be of great importance to land use in the future.

Another issue relevant to this kind of analysis is the integration of different scale analysis. Understanding the problems related to scale analysis must be a key issue in the study of the nature / society interactions. The different human activities must be evaluated or measured according to the different levels of the spatial and temporal scales (Gibson, C.; Ostrom, E.; Ahn, T., 1998). Therefore, if we search for answers at local level we must not forget the external driving forces in other levels of intervention, i.e. the regional and the global framework that influence the local or the individual level.

The issue of *spatial scales* is approached from a different perspective. Existing models may be defined as 'horizontal' in their approach to the spatial domain; interactions take place between phenomena operating at a similar spatial scale; inputs/outputs move vertically, either downward or upward, into larger or smaller spatial units. It is current opinion that aggregation and desegregation between the smallest spatial unit of production decision-making in the landscape, namely the farm, allows different spatial scales to be achieved, from the catchment to the national scales. This is a conceptually coherent approach, given that aggregation can result in information loss. Furthermore it allows the effects of large-scale phenomena, for instance shifts in market orientation or weather patterns, to be addressed through an assessment of modifications induced at the lowest scale of production. In this context, it is emphasised that farmer decisions are of paramount importance because they underpin the functioning of agriculture, and it is through farmer decisions that policy has an impact on agro-ecological resources. Adequate modelling of this decision-making process is fundamental in achieving the sustainable use of natural resources.

For the integration of the socio-economic perspective in the study of land use changes, it is not enough to collect data of the socio-economic type and to present its spatial pattern of distribution, or even its combination with spatial data. The integration of different disciplines requires the close collaboration between these disciplines, already at the stage of defining the datasets needed.

The information to be collected depends on the questions each scientific perspective has put to the same object, i.e. land use change, and also on the scale of analysis. Based on the definition of the problems, which need an explanation, each scientific approach has to identify the questions it may deal with, as a contribution to this explanation. And then, dialog is necessary for the understanding of the different questions, and of how the different approaches may contribute to each other's development within the subject. The process is not a simple one, and it is not possible with the work of a single scientific perspective, even if well motivated.

2. THE INTEGRATED METHODOLOGY APPLIED TO THE CASE OF COASTAL ALENTEJO

The development of the methodology to be applied and implemented begun within the scope of the study *Monitoring and Managing Changes in Rural Marginal Areas: a comparative research*[2].

The said research was based on the study of the head farmers' activity, in other words, his activity as an agricultural farmer and agent for change in the rural landscape. Thus, on the one hand, it was important to analyse their options with regard to the kind of product and production quantity (the production systems) and, on the other hand, to understand the farming trends which may be diversification, maintenance, extensification or intensification. If these trends reflect the land use changes, they also reflect the purposes and intents of the intervening actors.

The application of the proposed methodology to the monitoring and managing of changes in coastal areas make possible the linkage of demographic, economic and social data with information of a physical nature (soils and land cover).

These two groups of data will be introduced into the Geographic Information System (GIS) making for a spatial reading of the information. The effort of compatibility among the various kinds of data will make possible the integrated analysis. The GIS software makes possible also the quick adaptation of the analysis to the questions that will rise during the course of the research.

This procedure would require the characterisation of the region based on indicators (censuses, annual statistics, and data obtained by remote sensing techniques). The use of Corine and Lacoast information will be an important source to the identification of the land use changes.

At regional level the analysis should, therefore, be based on information obtained with instruments for remote detection (satellite images and aerial photographs) which permit the collection of information on land use in the coastal area for different periods and to carry out an evaluative analysis of the main changes in land use. On this level, official statistics can also be analysed to collect socio-economic information, which is fundamental for describing the region's general framework. These two types of information are complementary and fundamental for the identification of the main problems, which affect the region studied.

Simultaneously, it is necessary to study the main participants in the land's use. It is therefore, fundamental to understand the motivation of these agents when they use the land.

In this way, the study is carried out on two levels of analysis. On regional scale, it is possible to describe the region, and use official statistics and remote sensing to identify the main problems to be dealt with and the main changes in land use. At local level, a study is made of the social actors, and of the factors for change identified at regional level.

The study will identify and highlight three fundamental dimensions, which define a systemic articulation that structures the processes of change in coastal areas: the change in land use; the intervention of the various actors in the territory; and the regional and local dynamics.

Land use changes

The first step will be the identification of the land use changes and the characterisation of the natural framework in which they are involved.

The identification of the land use changes will be based on the CORINE Land cover database and the Lacoast datebase and it will be done with the co-operation of the CNIG – *Centro Nacional de Informação Geográfica*[3].

Human dimension and socio-economic and institutional framework

The methodology involves the main agents for land use changes and analyses their options regarding economic activities (agriculture, industry, tourism, services, etc.). The analysis of the actors' strategies will be carried out in relation to population, agriculture, industry and tourism statistics.

[2] This project , finished in 1997, was funded by the European Commission (DG VI) and carried out by multi-disciplinary research teams from Portugal, Belgium and Denmark. These teams studied the main processes in land use changes in rural marginal areas in some regions of their countries. The national co-ordinators were Nelson Lourenço (Universidade Nova de Lisboa, Portugal), Marc Mormont (Fondation Universitaire Luxembourgeoise, Belgium) and Esben Sorensen (University of Aalborg, Denmark).

[3] With the co-operation of João Reis Machado (PhD.) and the collaboration of Cristina Seabra (MSc.). The National Centre for Geographical Information is an organisation of the Ministry of Equipment, Planning and Territorial Administration. This centre develops research related to territorial ordinance, natural resources, environmental and regional planning.

The characterisation of the different groups of actors is an important step of the research, analysing in which way their behaviour and strategies induce the land use changes[4]. The result of this analysis will also be the understanding of the main regional socio-economic driving forces that condition the actors' behaviour and strategies.

The land use changes are also framed by a range of national and regional policies and other planning tools essential for the effective comprehension of the process of change.

An integrated analysis of regional and local dynamics

With the technical support of the CNIG, the study emphasises the compatibility between land use and statistical data. For this it is important the existence of Lacoast database and likewise the treatment of the statistical data done by the team, namely the of socio-economic data potentially compatible with the GIS analysis.

2.1. Regional Framework

The Portuguese mainland coast (832 km, Daveau, 1995) can be broadly divided into two coasts: the west coast and the south coast (Algarve). The west coast can be split into two main areas, one located to the north and one to the south of the Lisbon region.

The area, north of the Lisbon region, can be characterised by an older and intense urban and economic pressure expressed by a high population density (more than 100 inhabitants per km²) and by a network of diversified economic activities (fisheries, agriculture, industry, and services). The coastal area south of Lisbon, situated in the region of the Alentejo, is characterised by a low population density (less than 50 inhabitants per km²), the dominance of agricultural activities and services, and by a recent increasing urban pressure caused by tourism activities. The main institutional constraints regarding land use change, which cause some conflicts of interest between different social actors, are imposed by restrictive territorial ordinance measures and by the existence of a Natural Park. Industry, which is concentrated around the industrial harbour of Sines, is the main cause of problems in terms of environmental degradation in the region.

The southern part of the Portuguese coast, located in the Algarve, faces problems related to the huge urban pressure resulting from tourism activities. Here the environmental problems are mainly connected to the absence of territorial planning for decades.

This study shall focus on the coastal area of the Alentejo as the territorial unit of research, for two main reasons. In the said region we can identify a great diversity of activities and land use: agriculture in the north and south; industry in Sines county; and tourism related with the existence of small beaches.

It is also a region where environmental degradation is, for the time being, restricted to the areas near the industrial harbour of Sines. Nevertheless, the increasing pressure on the land due to an increase in tourism could, if not well planned, damage the environmental balance represented by the existence of the Natural Park of the Alentejo Coast.

Therefore the study aims to create a methodology to understand land use between 1975 and 1985. However, statistical and land cover data are not limited to this period, having been extended in such a way as to allow a longitudinal analysis, allowing the observation and understanding of more intense social transformations registered essentially in the last decade. Thus, data relative to the previous period and the period after were integrated; using data from the General population and Housing Censuses of 1970 and 1991, and 1995 land cover data obtained from the observation of aerial photographs that permit the observation of the most recent situation.

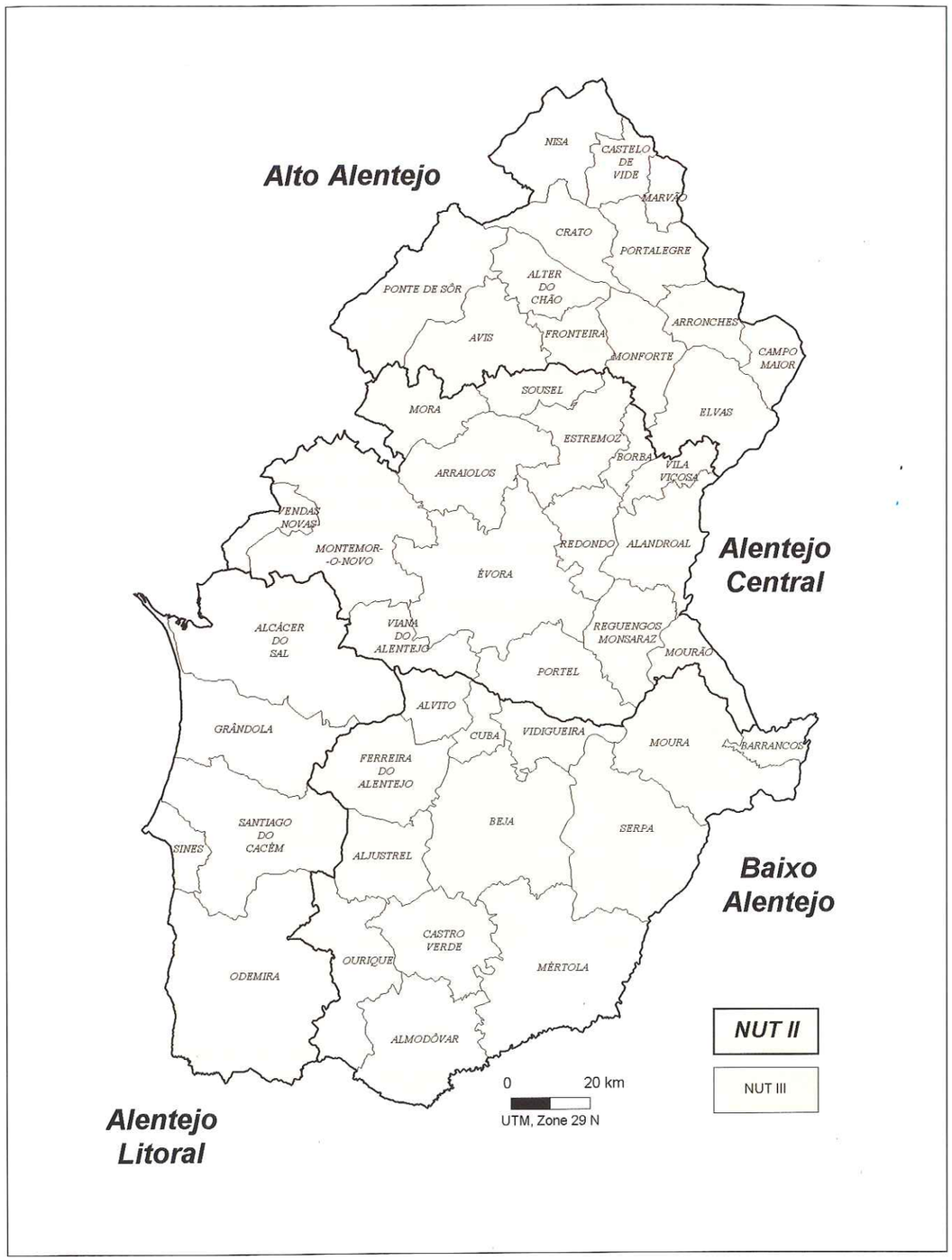
Aside from this temporal aspect, data collection was also carried out at two geographical levels of analysis: the Alentejo region, *Alentejo Litoral* and the coastal band of the latter.

Sources of cartographic and alphanumeric data range from remote sensing (satellite images and aerial photographs) to general population, housing, and agricultural censuses.

The Alentejo region is divided by NUTS III into *Alto Alentejo, Alentejo Central, Alentejo Litoral, and Baixo Alentejo* (Fig. 1 and Annex 1). These sub-regions are made up in turn by a total of 46 Alentejan municipalities, formed principally for statistical purposes.

[4] For example, in agriculture the presence of different biophysical and socio-economic contexts, head farmers with different socio-cultural characteristics and diverse land uses results in very different situations which, in order to be duly analysed, had to be grouped into a typology of farms and head farmers. In these example it is important to characterise the farmers and the conditioning factors in their choice of soil use and the environmental pressure on the agricultural land to understand the farming trends which may be diversification, maintenance, extensification or intensification.

Fig. 1 – Administrative division of Alentejo



2.1.1. Data Sources

The socio-economic data refer to two separate aggregates: on the one hand, the Alentejo **(NUT II)** where the preferential point of reference is the municipality, and on the other hand, *Alentejo Litoral* **(NUT III)**, where parishes were analysed.[5]

The data collected was organised into two large groups of variables: the demographic variables and socio-economic variables that can be seen as general indicators of development. Demographic and socio-economic indicators used are the resident population, the age structure of the population based on three main groups (the young, the "active", the old), the active population by sectors of activity, the non-active population, the pensioners and retirees, and the level of instruction of individuals.

Among the economic variables are agricultural indicators such as agricultural surface used and average surface per exploitation, industrial indicators such as turnover per industrial sub-sector (extractive, transformation, construction, and public works), and finally, business and tourism indicators such as the number of companies, the amount of labour, and the type of hotel equipment.

These data were collected in publications of the National Statistics Institute *(Instituto Nacional de Estatística)*, particularly in the General Population Census of 1970, 1981 and 1991, the General Agricultural Census of 1979 and 1989, Municipal Inventories (Alentejo Region, 1993) and Statistical Yearbooks (Alentejo Region, 1994 and 1995).

For *Alentejo Litoral*, the characteristics of agricultural producers, age structure, instruction and time dedicated to the activity, were analysed only in 1989. In this sub-region, data on buildings were still collected, both in terms of global values (total number of buildings and floors), and in terms of indicators of quality of life, such as the existence of electricity, sewers, bathrooms, etc.

Other Data Sources

In terms of external variables, preference was given to the Environmental Atlas and the Environmental Bureau. Texts on topography, hydrography, and geology were collected. These were considered fundamental to an initial approach to understanding the territory.

Anthropical variables were identified, especially the collection of data on the most structural communication routes (national roads, airports, and ports), large enterprises such as the industrial complex of Sines, and the tourist ventures of Tróia. Future projects were identified as well, particularly tourist projects that help to understand the pressure acting on particular areas of the territory.

In terms of institutions, data relative to restrictions and public right of free passage on natural resources were collected. One of the most evident texts is on the existence of nature conservation areas that, by legal definition, have direct implications on the management of the territory.

Part of this data comes from the need to compare some external or anthropical characteristics with the legal provisions that restrict the use of the territory. In this manner, it is possible to create delineations that help the spatial comparison of the institutional aspect with the socio-economic and biophysical dimension.

These various types of data were gathered for diverse territorial scales in order to fulfil one of the most important steps of the proposed methodology.

2.1.2. The Alentejo: Physical and Socio-economic Features

The climate is clearly Mediterranean in the region of the Alentejo, with a hot and dry season stretching from May to June. The rains are concentrated in the period between November and March. The occurrence of heavy downpours in the spring and autumn and the great irregularities in the yearly rainfall make it difficult to plan crops and necessary irrigation. The winters are fresh and mild with a minimum temperature varying between 2°C and 6°C, and the summers are hot with maximum temperatures exceeding 29°C. Climatic conditions are more moderate near the coast.

The rocky layer is fundamentally marked by the presence of schists, greywackes and granites, and occasionally, marble. In the Basins of the Tagus and the Sado, these rocks exhibit an essentially sandy clay sedimentary covering. The economic importance of these types of rock is reflected not only in big units that extract cupriferous pyrites from the Portuguese pyrite belt, but also in the relatively large number of companies, generally of small and medium size, that extract rocks for ornamental purposes and for use in civil construction.

[5] Local administrative organisation, in Portugal, is divided into two main units: *concelhos* (municipalities or councils), and *freguesias* (parishes).

The variations in soil quality within the region considered here are mainly connected with the changes in the parent material and with the topography. With the exception of small and narrow alluvial plains, the soils in this region are generally rocky; little developed, with a scarcity of organic matter, a low capacity for water capacity, often highly eroded and not very suitable to agriculture.

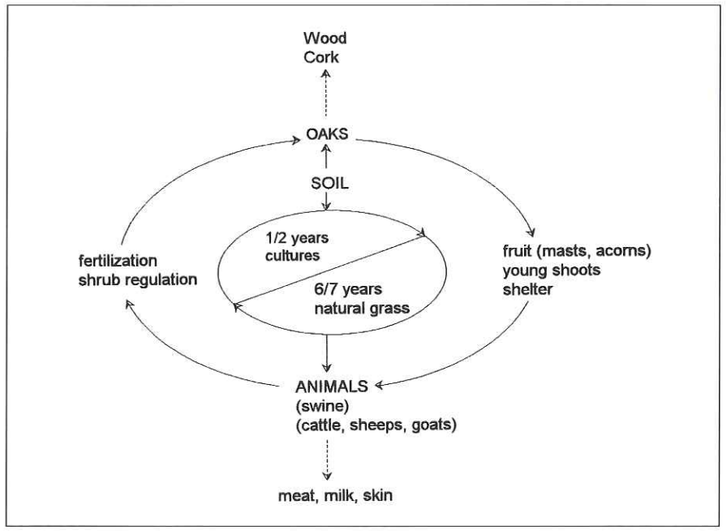
The landscape, which is dominated by the huge peneplain of the Alentejo where small ranges of hills rise up, notably the Serras de Grândola, Cercal and Ossa, is marked by the presence of *Montado* oak plantation constituting a system of extensive land use of the agro-silva-pastoral kind. It results from the selection of species from Mediterranean forest which Man has developed in the last two centuries (Natividade, 1950). It is particularly well adapted to the limiting climate and soil conditions and it is made possible by the large dimension of the holdings in the Alentejo.

On Coastal Alentejo, the *montado* is mostly composed of cork oaks (*Quercus suber*) on account of the ocean's influence that makes the climatic conditions mild. In the interior of the Alentejo where drought is more intense and the temperatures more extreme, the holm oak (*Quercus ilex and Quercus rotundifolia*), a species better adapted to these conditions, is predominant.

In terms of land, the *montado* is used for growing cereals in rotation with planted pastures which are followed, generally for four or five years, by a fallow period during which the shrub strata develops. This shrub stratum is composed of Mediterranean species such as: gum cistus *(Cistus ladaniferus)*, sargasso *(Cistus monspeliensis)*, great leaved cistus *(Cistus albidus)*, rockrose *(Cistus crispus)*, lavender *(Lavandula stoechas)*, rosemary *(Rosmarinus officinalis)*, winged broom *(Pterospartum tridentatum)*, heath tree *(Erica arborea)* and thorn *(Ulex densus)*. Apart from protecting the soil, this shrub stratum allows for nutrients to be fixed in the soil and for the natural re-growth of the cork oaks. At the end of this fallow period, the land is ploughed and the scrub cut back.

The *montado* is an important habitat for wild animals (partridge, quail, thrush, rabbit, hare, wildcat, etc.) and is good for apiculture, mushroom and herb picking. It can be considered an almost closed system, as is illustrated in Fig. 2. The agro-forest-pastoral components are present and complementary. Man's traditional management has focused on maintaining the balance and reaping the produce (Correia, T. Pinto, 1992).

Fig.2 - Montado: an agro-forest-pastoral system



Source: Adanted from Correia. T. Pinto 1992

The holm oak *montado* seems to have developed a long time ago (Daveau, 1995) mostly as a result of the production of very nutritive acorns. In the winter and autumn, these constitute an important complement to the nutrition of flocks of sheep and goat which, during the spring and summer, also eat the greener leaves of the trees and the shoots from the scrub (Correia, 1992). Until the development of African swine fever, the holm oak

montado was also a key factor in extensive Iberian pig *(porco alentejano)* farming.

On the cork oak *montado* that expanded notably as from the beginning of the 20th century (Daveau, 1995), the extraction of cork is the most important activity given that the density of trees generally relegates seed corps and pastures to second place (Correia, 1992). On the other hand, the cork oak acorns *(landes)* are less nutritious than those of the holm oak are and so their use as cattle fodder is less important.

Given that cork is only cut every 9 or 10 years, on the large holdings, the *montado* is divided in sectors and the cork extraction is spread over several years, which allows an annual income to be maintained. However, various factors have contributed to the degradation of this land use system:

The Wheat Campaigns in the thirties and the mechanisation of cereal growing, since the sixties, initiated intensive phases of cereal growing and pasture use that exerts a great deal of pressure on the *montado* in the Alentejo. African swine fever, which spread in Portugal in the beginning of the seventies, led to the end of extensive Iberian pig *(porco alentejano)* farming. For these reasons the economic viability of the holm oak *montado* almost disappeared and it is declining, the density of its trees is diminishing; the latter were generally transformed into vegetal coal, giving way to clean land where the mechanisation of cereal farming was possible (Ferreira *et al,* 1993).

Over the last years the area of cork oak *montado* has stabilised, however, intensive cereal growing and pasture use do not allow for the natural regeneration of the cork oaks and as a result the trees are generally old, in decline, and less productive in terms of cork (Daveau, 1995). The periods of drought felt in the nineties have also contributed to the general weakening of these trees.

Evolution of the Resident Population of the Alentejo

Analysis of the evolution of the population of the Alentejo points to a decrease of inhabitants from 593 215 in 1970 to 586 389 in1981 e 543 442 em 1991. However, these values must be interpreted taking into account the differences between NUTs III and the municipalities in the different periods considered. The resident population in Évora and Beja is always more than 30 000 inhabitants, reflecting the importance of the main urban centres of the region.

The characteristics of demographic growth in the 70s and 80s are distinct (Fig. 3). There are thirteen municipalities with positive growth rates in the 70s, notably the municipalities of Sines and Vendas Novas where growth rates exceeding 20% are recorded. In the 80s, only five municipalities show positive population growth rates, among which to be noted are the adjacent municipalities of Sines-Santiago do Cacém and Évora.

The demographic evolution of each municipality reveals some common traits in the periods analysed notably the persistence of negative growth rates in the municipalities of Lower Alentejo, with the exception of the municipality of Beja, which, between 1970 and 1991, shows a positive growth. It is in this sub-region, South and Southeast Alentejo, that the highest tendency for depopulation is registered.

In Upper Alentejo, the municipalities that register population increases between 1970 and 1981 are Portalegre, as a result of the dynamic economy of the city with the same name, Elvas and Campo Maior, due to the influence of their proximity to the border and the consequent intensity of commercial transactions. Despite these factors that point to a relative economic growth between 1981 and 1991, all the municipalities of this sub-region show negative growth rates.

Some patterns can be seen as well in *Alentejo Litoral*, particularly the positive growth of the population of the municipalities of Sines and Santiago do Cacém, and the negative growth of the population of the municipality of Odemira. In the former, these figures reflect the influence of the industrial zone of Sines, and in the latter, the loss of the importance of the population connected to agricultural activity in Odemira.

In Central Alentejo, constant positive growth can be noted in the municipality of Évora, which remains an important urban pole of the region.

In summary, the analysis of population growth rates reveals, beyond the district capitals, a small nucleus located near the more dynamic border (Campo Maior, Elvas and Vila Viçosa) and the municipalities of Sines and Santiago do Cacém. The municipality of Sines registered the highest growth rate for the period analysed.

Population Density

In the territory of Continental Portugal, the Alentejo is traditionally the region where there have been the lowest population densities.[6] Based on the information found in the population density map of the region of the Alentejo for the years 1970, 1981 and 1991 (Fig. 4), one can verify that the municipalities of this region have population densities generally lower than 65 inhabitants per km².

Aside from the municipalities that constitute district capitals, it is in the municipalities of smaller dimension, such as Sines, Vendas Novas, Borba and Vila Viçosa, that there are higher population densities, with the exception of Beja.

Population growth rate

Alentejo, 1970/81/91

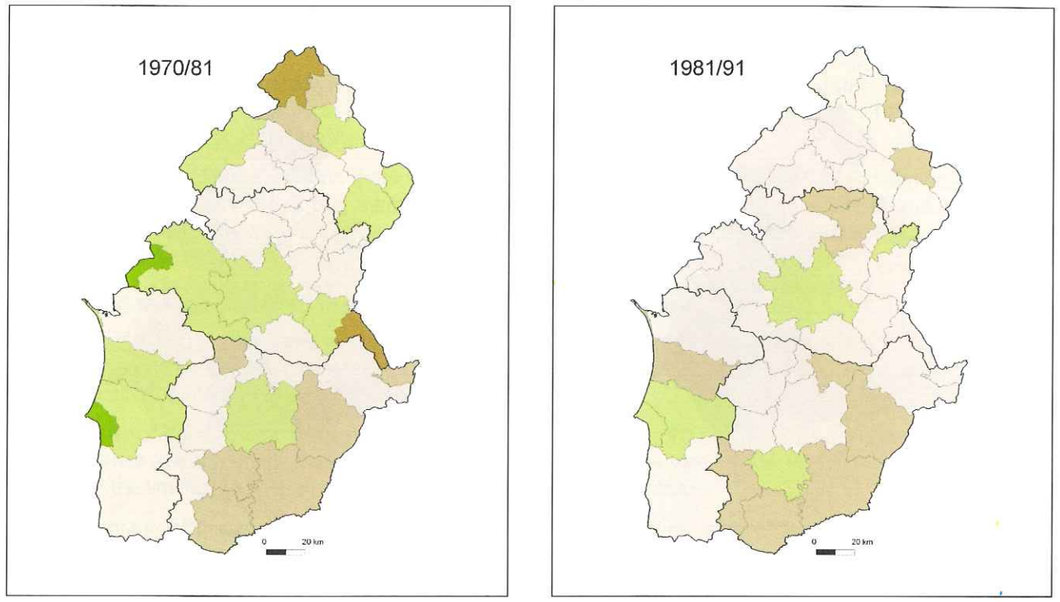


Fig. 3 - Source: INE, XI, XII, XIII Recenseamentos Gerais da Populacão, 1970,1981,1991

[6] In the context of the continent, that showed in 1991 a population density of approximately 106 people / km², the region of the Alentejo has the lowest density: Northern Region, 163 people / km²; Central Region, 73 people / km²; Region of Lisbon and the Tagus Valley, 276 people / km²; Region of the Alentejo, 20 people / km² and Region of the Algarve, 69 people /km² (1991 Census and S. Daveau, 1995).

Population density

Alentejo, 1970/81/91

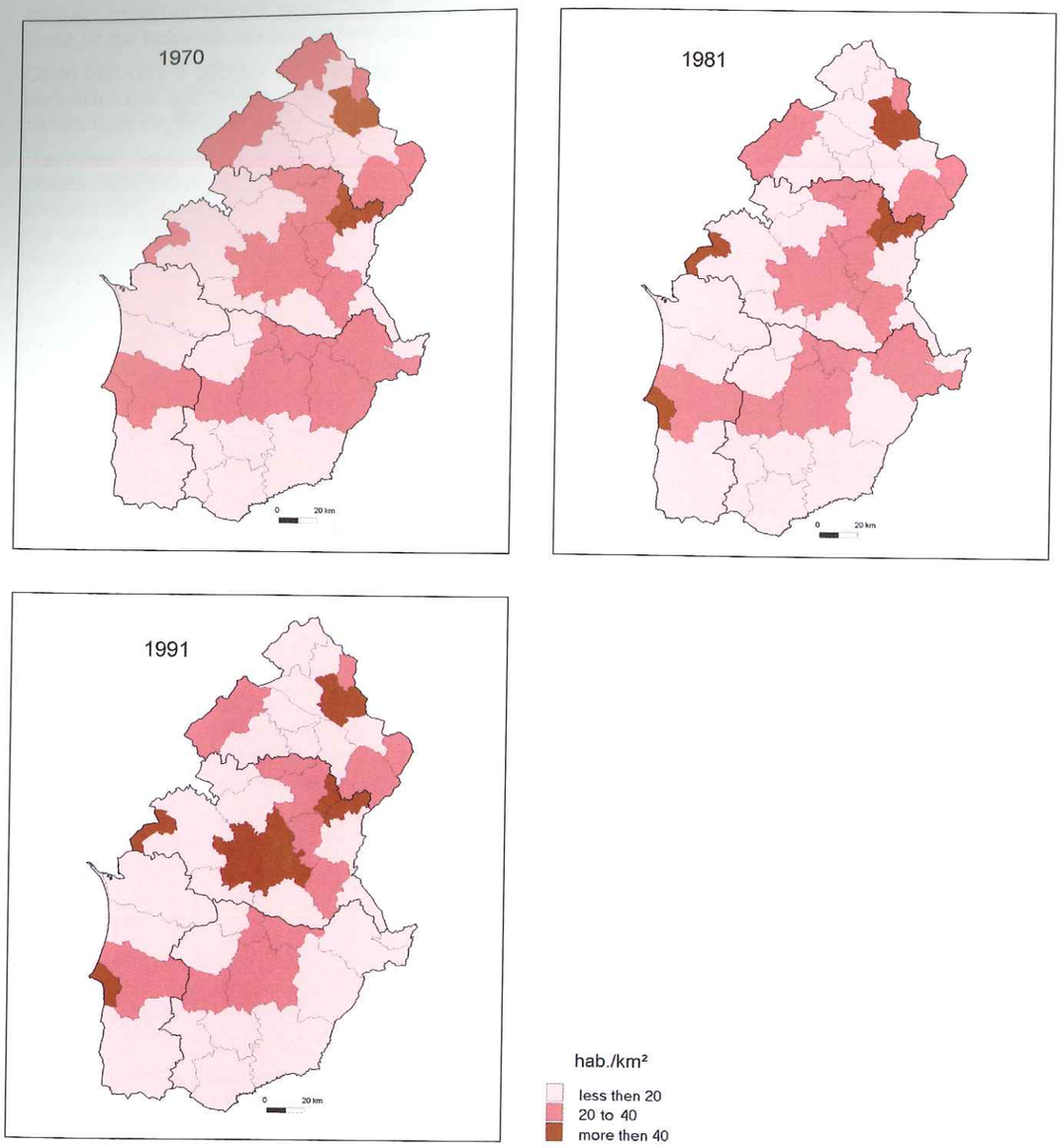


Fig. 4 - Source: INE, XI, XII, XIII Recenseamentos Gerais da Populacão, 1970,1981,1991

However, most of the Alentejo is comprised of municipalities with population densities of less than 20 people / km². Among these are the municipalities of Alvito, Avis, Ourique, Mértola, Monforte and Alcácer do Sal with extremely low figures at less than 10 people / km².

Based on the population density variation map for the period between 1981 and 1991, it can be observed that only five municipalities (Santiago do Cacém, Vila Viçosa, Évora, Castro Verde and Sines) had a population density

growth between 1981 and 1991. The increase of the population in Santiago do Cacém and Sines is related to the presence of the industrial area of Sines that is an important population attraction centre in Sines itself, and more ntensely, in the municipality of Santiago do Cacém where the new city of Santo André, an urban centre created with the intention of lodging labour population of the Industrial area of Sines, is located.

Évora is a municipality where population growth has made itself felt, although moderately, mainly in relation to the development of the city as an important tourist and administrative centre of the Alentejo. The growth of this municipality can be contrasted with that of Portalegre and Beja, which, although are district capitals as well, do not seem to have a big capacity to attract and to settle the population, given that between 1981 and 1991 they had a decrease in population density by 5% and 7%, respectively.

Meanwhile, the Alentejo is a region that experienced a continuous population rarefaction and diminishing density during the 80s. Figure 4 shows that there was a decrease in population density between 1981 and 1991 by 5 to 20% in a large number of municipalities, with the municipalities of Ourique and Marvão reaching figures of -21% and -22%, respectively.

The Age of the Population in the Alentejo and the Ageing Process

As other regions in Portugal and other industrialised countries, the Alentejo confronts a process of demographic ageing. This phenomenon is characterised by a substantial increase in the number of the aged, mainly in relation to the number of young people.

The number of aged rose in Portugal between 1970 and 1991 from 10.7% to 13.6% of the total population. The reference average of the twelve European Community countries was 14.3% in 1991, and three countries exceeded the limit of 15%: Germany, Denmark and the United Kingdom.

The percentage of the aged in the Alentejo is higher than in the entire country, going from 11.4% in 1970 to 19.3% in 1991. All the NUTs III of the Alentejo show figures exceeding the national average in 1991. The Upper Alentejo has figures showing the oldest population: 12.9% aged in 1970 and 21% in 1991. *Alentejo Litoral*, which shows 16.8% aged in 1991, coincides to the least-aged NUT III in the Alentejo. However, the pattern of evolution toward a greater ageing of the top of the pyramid is very similar in all the NUT III of the Alentejo and much higher than the national average for the per d analysed.

The ageing of the segment of the oldest people is a reality as well. In Portugal, the segment of the population over 75 years old represents 39% of the aged in 1991 (34% in 1981). In the Alentejo, the figure was lower than the national average (33.6%) in 1981, and in 1991, it became the oldest region in the segment of the aged at 42%. *Alentejo Litoral*, which had the second youngest segment of aged people in 1981, reached a figure above the national average in 1991 (39.4%), 8% more than in 1981.

The ageing of the population is also evident in the drop of younger segments in Portugal and in the Alentejo. Nevertheless, ageing due to the decrease in the segment of the younger population assumes different levels when analysed in the various regions of the country. Thus, the relative weight of young people in Portugal diminished from 28.1% in 1970 to 19.7% in 1991.

In 1991, the Alentejo had the oldest population at the base of the age pyramid (17.4%); the oldest young population being in Upper Alentejo (Table 1), such as is the case with the aged population. Lower Alentejo recorded a more marked decrease and in 1991, *Alentejo Litoral* had the youngest of the young segments among all of the Alentejan NUTs III.

The highest percentage of young people (>14 years old) is found in the municipalities of Beja, Moura, Vila Viçosa, Évora, Elvas, Campo Maior, Santiago do Cacém, Mourão and Sines, with figures varying between 19% and 20%. In the municipalities of Nisa, Crato, Marvão, Arronches the proportion of young people is less (<15%).

In 1991, the 25-44 and 45-64 age brackets generally correspond to the active population. The younger active age bracket (25-44 years old) are more significant in the municipalities of Vila Viçosa, Évora, Santiago do Cacém and Sines, where the highest percentages are registered (27-29%).

In short, the analysis of the distribution of the aged population in the Alentejo highlights the situation in Upper Alentejo where there is generally a high level of ageing in its municipalities. The evolution of the young population in Lower Alentejo is significant for the reason that it is a group of municipalities that had a higher percentage of young population and many of these municipalities became very old, mainly in the young segments. In the *Alentejo Litoral*, ageing never reached high levels, when compared with the figures in the region. It is in this NUT III that one can find the municipality that shows the lowest level of ageing at the base as well as the top of the pyramid and in all of the Alentejo: the municipality of Sines.

Table 1 – Resident Population and Age Structure, in Alentejo by NUT III, 1991

	Total	Aged	Young	%	
				Aged	Young
Alto Alentejo					
1970	139390	18015	30485	12.9	21.9
1981	137609	24291	27357	17.7	19.9
1991	130353	27436	21814	21.0	16.7
Alentejo Central					
1970	182670	19610	40875	10.7	22.4
1981	186682	27455	39087	14.7	20.9
1991	179232	32331	31081	18.0	17.3
Baixo Alentejo					
1970	171305	20430	41515	11.9	24.2
1981	158957	26880	33986	16.9	21.4
1991	143020	29064	25143	20.3	17.6
Alentejo Litoral					
1970	99850	9850	21985	9.9	22.0
1981	103141	14393	21512	14.0	20.9
1991	98519	16539	18083	16.8	18.4

Source: INE, Population Census, 1979, 1981, 1991

The big transformation in terms of ageing in the Alentejo between 1970 and 1991 occurred with a certain "ruralisation" of this phenomenon. The aged population homogeneously distributed in the Alentejo in 1970, with the exception of a small ageing nucleus in Upper Alentejo, becomes one of the most important indicators in 1991 for the distinction of the urban municipalities (less aged) from the rural municipalities (more aged). If a young population was characteristic of the rural areas in 1970, it abandoned them in 1991. This abandonment may be explained by the attractive effect that urban areas have, as a consequence of the concentration of services and commercial activities allowing a population to settle.

The ageing of the population at the top of the pyramid has consequences in terms of the weight of the female population relative to the male population, given that it is at the level of the most aged segments that the biggest influence of the number of women is reflected. In 1981, the male population is larger than the female population in three municipalities, two of which are located in the *Alentejo Litoral*. In 1991, this relation can be seen only in two municipalities. These exceptions are explained by the presence of a largely masculine population of active age.

The differences among the various age brackets are expressed not only in terms of socio-economic and cultural levels of the population, but also in the migratory movements that affect them. Hence, an analysis of the spatial variation of the different brackets allows us to identify certain elements that help to characterise the various municipalities of the region in relation to their capacity to attract and settle population.

Thus, the municipalities of Portalegre, Évora and Beja, which are the capitals' districts that comprise the region of the Alentejo, and which therefore show a concentration of services related to public administration, are generally those that have a more favourable situation in terms of characteristics of the population. These municipalities thus seem to demonstrate a certain capacity to attract population, or at least to settle the younger segments.

Apart from these three municipalities, there are still others in reduced numbers, that seem to have similar characteristics. This is the case of the municipalities of Sines, and consequently that of Santiago do Cacém in the *Alentejo Litoral*; that of Borba and Vila Viçosa in the Central Alentejo, that of Campo Maior and Elvas in the Upper Alentejo; and to a certain degree that of Aljustrel and Castro Verde in the Lower Alentejo.

The Level of Instruction

The highest level of illiteracy recorded is in the inland of Continental Portugal in 1991, notably in the regions of the Alentejo and the centre inland (higher than 20%). Less than 40% of the population of the region of *Alentejo Litora*l has only Primary Basic Education, despite the fact that it is a population with very low level of instruction.

This increase of education corresponds to the drop in the number of illiterate persons and the increase of individuals that complete primary schooling. Meanwhile, the highest levels of education continue with hardly significant figures and are associated with the existence of a younger and more urban population.

In general, the level of instruction in the Alentejo increased between 1970 and 1991. In 1991, the population that could neither read nor write, nor had obtained any level of instruction at all, is comprised of two big groups: the very young (less than 14 years of age) of pre-school age or attending basic education and older persons (45-64 years of age and more than 65 years of age), which comprise the largest group of this segment of the population. The fact that the population between 15–44 years of age is hardly represented in the group of those who have not obtained any level of education reflects very well the success of the expansion of mandatory education.

Thus, it is possible to state that the evolution of the levels of instruction in the Alentejo reflects the rhythm of transformation of the structure of the population in the region. However, the regional increase in the level of instruction has not accompanied the general evolution on a national scale, which reflects the low renewal of generations in the Alentejo, when compared to other regions on the continent.

Employment by Sectors of Economic Activity

In 1991, activities in the tertiary sector in the labour market constitute approximately 51% of the population. However, the heavy weight of the primary sector in the employment of people shows how the secondary sector is not sufficiently dynamic to absorb this excessive number of agricultural workers in the region.

Figure 5 shows an overview of the main activities in the region and their employment capacity. The distribution by municipality of the population employed in the primary sector in 1991 emphasises the fact that the activities of this sector remain a very important percentage weight in almost all the municipalities in the Alentejo. On the average 23,2% of the population of the municipalities of the Alentejo are in agriculture, forestry and fisheries.

The lowest figures (10-15%) are found in the municipalities of Sines, Beja, Vila Viçosa and Évora. The municipalities of Odemira, Odemira, Sousel, Ferreira do Alentejo and Portel should be highlighted as well since the activities of the primary sector represent an excessive weight (more than 40%) in the framework of the active population.

Labour in the secondary sector in the Alentejo, is marked by the population that is employed in the manufacturing industry and in construction. Mining industries have an almost residual significance in the region as a whole, although locally they may be a determining factor in the labour supply, mainly with regard to the extraction of ornamental rocks and stones for construction (Fig. 5).

Meanwhile, the manufacturing industry of the Alentejo suffers as well from the models of industrial growth applied in Portugal that have led to the concentration of industry in the coastal area, especially in the metropolitan areas of Lisbon and Porto.

The manufacturing industry in the Alentejo is fundamentally comprised of traditional branches among which are food and drink, tobacco with a reduced productivity, a large number of small-sized enterprises frequently of the family business type and very often cottage industries. However, this contrasts with the very strong industrial concentration in the area around Sines, whose growth has been accompanied by the installation of important units in chemical industries and petroleum derivatives.

The analysis of the population employed in secondary activities shows two large groups of municipalities: those where the population with activities in the secondary sector is lower (< 20%), clearly showing a separation in two geographical areas (a group of municipalities in the Upper Alentejo situated near the border, and another group situated in the Lower Alentejo); and those municipalities where the activities of the secondary sector have a heavier weight (> 30%), next to the industrial area of Sines (Sines and Santiago do Cacém), in the areas of the municipalities of Aljustrel, Castro Verde and Almodôvar , in the areas of the municipalities of Borba, Vila Viçosa and Alandroal, and still, in the municipalities of Vendas Novas and Arraiolos.

Regarding the municipalities of Santiago do Cacém and Sines, the main branches of activity correspond not only to the industries present in the industrial area of Sines but also to food, drink and tobacco industries as well as wood and cork industries that have a high employment capacity in these two municipalities.

Employment by sectors of economic activity

Alentejo, 1981/91

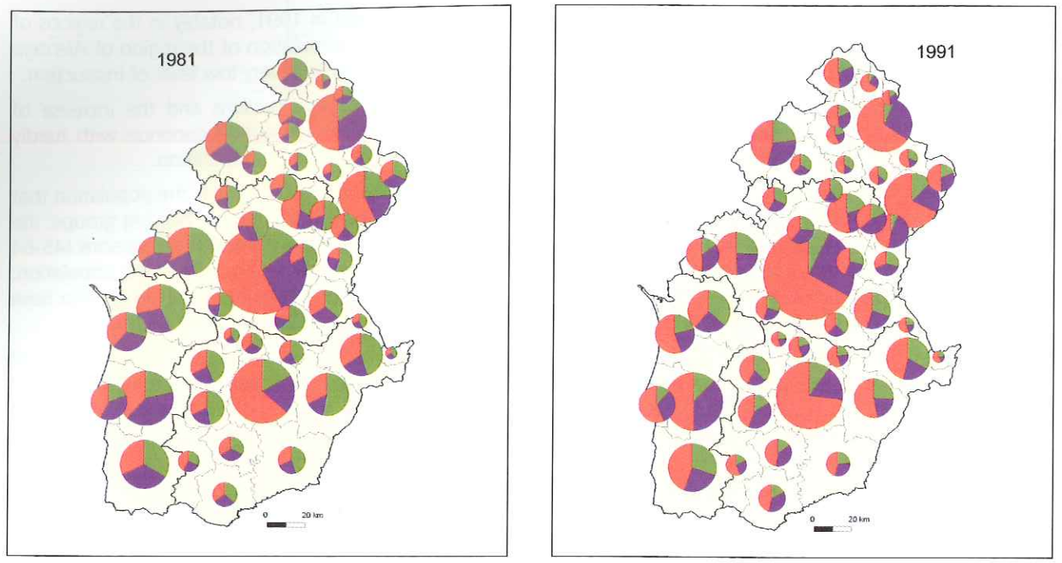


Fig. 5 - Source: INE, XII, XIII Recenseamentos Gerais da População,1981,1991

As for the area of the municipalities of Aljustrel, Castro Verde and Almodôvar, aside from food, drink and tobacco industries, and wood and cork industries, industries related to the manufacture of metal products, machines, transport equipment and material have emerged as well with some importance, having a lot of significance as support to agricultural activities.

Food, drink and tobacco industries and wood and cork industries are also present in Borba, Vila Viçosa and Alandroal, but apart from these, there are the industries of non-metallic mineral products that are employment factors of the populations of these municipalities. In addition, mining activities of ornamental rocks, particularly Marble of Estremoz *(Mármore de Estremoz)*, are practised in this region.

In Arraiolos, other than food, drink and tobacco industries, there are also textile, clothing, and leather industries, and the manufacture of metal products, machines, equipment and transport material, which are the most important in the municipality.

The municipality of Vendas Novas manifests a larger diversity at the level of manufacturing activities such as: food, drink and tobacco industries; textile, clothing and leather industries; wood and cork industries and the manufacture of metal products, machines, transport equipment and material.

Services and businesses constitute a very strong proportion of the active population of the Alentejo with figures that on the average approximate 50%. However, this rate shows big differences among the various municipalities of the region.

Thus, municipalities such as Alandroal, Borba, Portel, Arraiolos, Odemira, Alcácer do Sal and Avis (where above all, the weight of the population employed in the primary sector is very strong) show figures of population employed in the tertiary sector at less than 40%. On the other hand, there is a set of four municipalities with figures above 60%: Portalegre, Elvas, Évora and Beja. These four municipalities correspond to the district capitals of the Alentejo and, in the case of Elvas, to a municipality that connects to the exterior whose growth is fundamentally due to cross-border business.

Among the three capitals of district , Beja has the biggest percentage of the population employed in the tertiary sector (71%). This is due to the disappearance of other sectors of activity, translating into the absence of economic activities with employment power.

The existence of a strong tertiary sector, which has been growing in recent years, may help to create conditions for the modification of productive organisation, mainly if this tertiary sector is based on the existence of support services to economic activities. However, when the composition of the tertiary sector in the Alentejo is analysed, it can be noted that in a large number of municipalities, the weight of the tertiary sector of social nature is very big, and in many cases more than 50% when compared to the tertiary sector related to economic activities. There are the extreme cases of the municipalities of Arronches (56%), Alter do Chão (58%), Mourão (68%) and Barrancos (71%) where the existence of work opportunities is scarce and the population is aged.

Dominant Sectors of Economic Activity

Employment in the tertiary sector is generally dominant in the sub-regions of Continental Portugal. The region of the Alentejo is in fact a region where, between 1981 and 1991, employment of the resident population recorded a very significant change from the primary to the tertiary sector. However, it was noted that this tertiary sector is highly marked by the excessive weight of social services, which, in this region corresponds to approximately 44% of employment in the tertiary sector of the region. In this manner, a large part of the workpower employed in the tertiary sector is not responsible for the stimulating activities of other sectors of the economy of the region.

The dominant sectors of economic activity in each of the municipalities of the region of the Alentejo are also represented in Figure 5. A sector of activity was considered predominant when the percentage of the population employed by it was superior to 50%, and dominant when the sector with the highest percentage of population did not reach this figure. The reading of this map shows that of the forty-six municipalities of the Alentejo, thirty-nine have a dominant (24) or predominant (15) tertiary sector. On the other hand, the primary and secondary sectors were only dominant in four and three municipalities, respectively.

The municipalities where the primary sector is dominant (Portel, Ferreira do Alentejo, Odemira and Alcácer do Sal) correspond to regions where the agricultural activities and the tertiary sector (with very high figures for the tertiary related to economic activities) have a similarly very important weight (30-40%) in the employment of the population.

Although it is in municipalities such as Sines where the largest industrial units of the Alentejo are found, it is in a group of three municipalities of Central Alentejo, located next to the border with Spain, that the secondary sector is dominant. While the secondary sector is mainly comprised of manufacturing units of the food, drink and tobacco sector and of non-metallic mineral products in these municipalities (Borba, Vila Viçosa and Alandroal), they show diverse situations: Alandroal has a relatively lower figure (30%) of the active population in the tertiary when compared to the other two municipalities (35-40%). Borba and Vila Viçosa, on the other hand, have lower figures of the active population in the primary sector (20% and 10%, respectively), lower than those recorded in Alandroal (33 %).

As for the municipalities where the tertiary sector is dominant, those that are predominant are the following: Nisa, Crato, Arronches, Mourão, Vidigueira, Grândola, Cuba, Sines, Barrancos, Alter do Chão, Castelo de Vide, Portalegre, Elvas, Évora and Beja.

Among these municipalities, the tertiary sector occupies a big proportion of the active population in the district capitals (Portalegre, 62%; Évora, 66%; and Beja, 71%) and in Elvas (65%), municipalities where the primary sector shows relatively low figures (9-16%) when compared to the rest of the region of the Alentejo.

In the capitals of district , relatively high percentages of population employed in tertiary activities of a social nature can be observed as well, while these figures are lower in Elvas where the tertiary supporting economic activities register figures to the rate of 60%.

In Upper Alentejo, next to the border with Spain, the tertiary sector is predominant also for another group of municipalities: Nisa, Crato, Arronches, Alter do Chão and Castelo de Vide. It can be observed that while Marvão and Campo Maior are geographically near, they do not show such high figures in the tertiary sector, mainly because the activities in the primary and secondary sectors show some employment capacity in these municipalities.

Likewise with a similar geographical position (next to the border), the municipalities of Mourão and Barrancos have very high figures (52 – 55%) of the active population in the tertiary.

A common element in these two groups of municipalities is the existence of a tertiary sector of a social nature at an extremely high rate, with figures ranging between 51% in Crato and 71% in Barrancos.

Finally we observe a group of four municipalities where, despite registering very high figures in the tertiary (53 – 55%), the proportion of this sector related to economic activities, is likewise very high. These four municipalities are Sines and Grândola, situated in *Alentejo Litoral*, Cuba and Vidigueira in Lower Alentejo.

The inclusion of the municipality of Sines in this group where the tertiary sector is predominant becomes curious, given that it is in this municipality that one of the most important industrial areas of Portugal can be found. However, this situation could be explained by the small size of the municipality, which explains the presence of some industrial units in the neighbouring municipality of Santiago do Cacém. It is in this municipality as well that the urban centre (Cidade de Santo André) that receives a large part of the population working in the area of Sines is found. Thus, when the distribution of the active population of the municipality of Santiago do Cacém is analysed, the importance the secondary sector (35%) represents in this municipality can be seen.

The tertiary sector is the predominant activity in almost all of the Alentejo in 1991. Exceptions arise in the municipalities of Alandroal and Borba, where employment in industry predominates. The Centre East area of the Alentejo is influenced by industry, including mining extraction.

The commercial and service sector predominate more (more than 50% of the total) in the bigger cities of the Alentejo, those which centralise more services of an administrative character and simultaneously provide more support in terms of equipment needed outside the municipality. The importance of the small municipalities in terms of employment in the tertiary sector is likewise particularly relevant, for the reason that, having reduced populations, the administrative body of the town halls constitutes a large portion of the total population with registered economic activity.

The importance of the primary sector is minimal, not being the sector with the highest employment capacity in any of the municipalities of the Alentejo, in 1991.

Retirees and pensioners form one of the most numerous segments in most of the municipalities of the Alentejo. Comprised of individuals more than 65 years of age and individuals, who, despite being of active age, do not have a professional occupation anymore, this segment is even more numerous than the total active population.

The relative weight of the primary sector was substantially higher in 1981, the loss of importance of the primary sector in a high number of municipalities being very recent. The spatial distribution of this change that occurred in the 80s is very uniform throughout the region.

The segment of pensioners and retirees, which registers a very clear increase between the two censuses, could be "hiding" a significant part of the population that continues to work in agriculture, but are not registered for statistical purposes in this activity.

Spatial Mobility of the Population

Of the 543 442 residents of the region of the Alentejo on 15 April 1991, 24 401 were residing on 31 December 1985 in another municipality of the country and 3 610 were found to be residing abroad. People who relocated to the Alentejo from other regions of the continent account for approximately 5% of the resident population in 1991. However, this is a region that has a negative balance in terms of internal migrations, 30 805 people having left for another municipality of the country or, more specifically, 6% of the resident population.

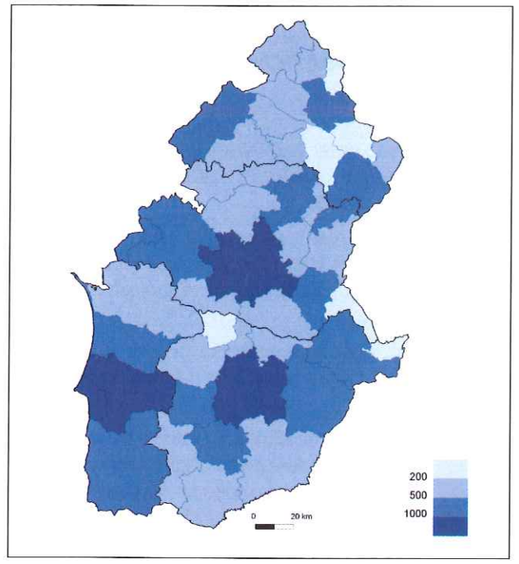
Municipalities that register in that period a larger migration of the population are the capitals of district and the municipalities of Elvas, Sines, Santiago do Cacém and Odemira (Fig. 6). Among these municipalities Santiago do Cacém, Évora and Beja, where 2 000 persons per municipality left, clearly stand out.

The municipalities of Barrancos, Castelo de Vide, Alvito and Arronches are those where one can observe lesser amount of migrations. These are the least-populated municipalities as well.

As for the entry of people in the municipalities of the Alentejo (Fig. 6), the municipalities that have a larger capacity (more than one thousand persons per municipality) to attract population are the ones of Sines, Beja, Santiago do Cacém and Évora. It can also be noted that Odemira, Elvas and Portalegre register large entry flows of population (800-900 people).

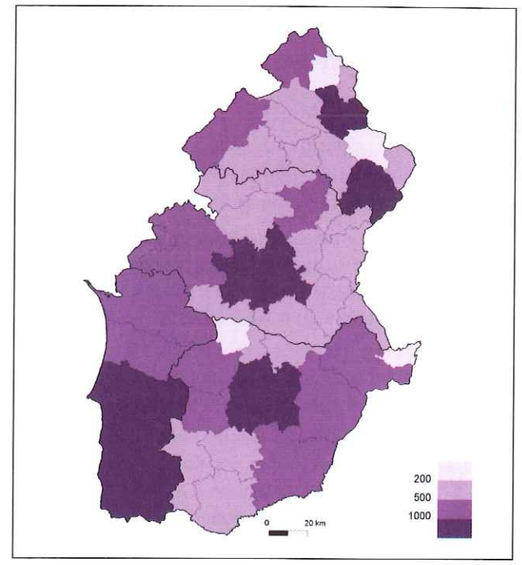
Population that left the municipalities

of the Alentejo 1985-91



Population that entered the municipalities

of the Alentejo 1985-91



Population that entered the municipalities

of the Alentejo coming from abroad 1985-91

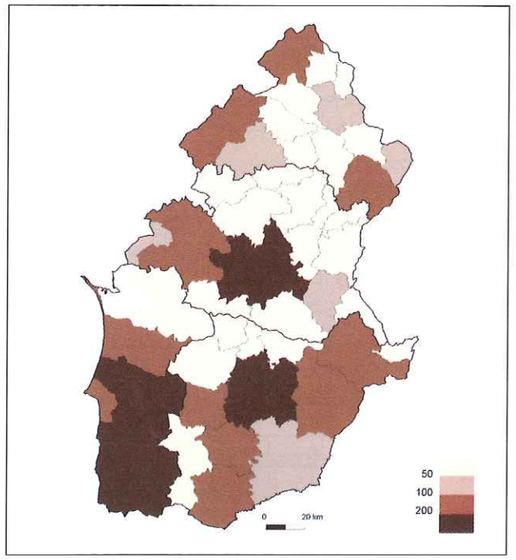


Fig. 6 - Source: INE, XIII Recenseamento Geral da População,1991

This shows that the municipalities with a larger capacity to attract population are also those where there are the largest exit flows, or in other words, they are municipalities with little capacity to settle the population that arrives there from other municipalities. On the other hand, the municipalities of Barrancos, Alvito, Marvão, Arronches, Mourão and Monforte register weaker population entry flows but in some of these cases (Mourão, Monforte e Marvão), significant exit flows as well.

With regard to the population coming from abroad and entering the municipalities of the Alentejo (Fig. 6), it can be observed that the total volume (3 610 persons) is hardly significant. However, it can be noted that 35% of these people are found in the municipalities of Elvas, Beja, Odemira, Santiago do Cacém and Évora.

Balance of Internal Migrations

Between 1985 and 1991, there is a negative balance between persons who enter and leave in the various municipalities of the Alentejo (Fig. 7). This shows us that the region as a whole is not capable of settling the population, which tends instead to emmigrate to other regions of the country or even abroad.

The volume of the population that entered and left the municipalities of the Alentejo between 1985 and 1991 is relatively small, and this can be explained by the hardly significant weight of the population in mobility in this region, as mentioned above. Nevertheless, it is possible to emphasise some municipalities where the exit and entry of people are more significant (Table 2).

This table shows that when taking into account the resident population, population entry in general is less than the exit, a fact that is not surprising, given that it is a region where there is a negative balance in terms of migratory movements in the interior of the continent.

The municipalities where population exit has a greater weight, in the context of the resident population, are Monforte, Alvito, Marvão, Mourão, Sines and Beja where the population that left the municipalities corresponds to approximately 7 – 9% of the resident population. On the other hand, the municipalities where the exit of people was less felt were Campo Maior, Castro Verde, Reguengos de Monsaraz, Almodôvar, Vila Viçosa, Évora and Elvas, where the population that left the municipalities corresponds to less than approximately 5% of the resident population.

Table 2 – Weight of the population that entered and left the municipalities of the Alentejo

Municipality	Entry	Exit	Municipality	Entry	Exit
Alcácer do Sal	1,9	5,2	Ourique	4,4	6,0
Marvão	2,9	7,8	Almodôvar	4,6	4,4
Moura	2,9	5,5	Aljustrel	4,6	5,0
Campo Maior	3,0	2,9	Nisa	4,6	5,5
Odemira	3,0	5,3	Reguengos Monsaraz	4,7	4,3
Borba	3,1	4,9	Arronches	4,7	5,2
Redondo	3,2	4,5	Barrancos	4,7	4,6
Elvas	3,3	4,4	Arraiolos	4,7	5,1
Portel	3,4	5,2	Beja	5,0	9,3
Alandroal	3,4	6,5	Crato	5,2	5,0
Portalegre	3,4	5,1	Monforte	5,3	7,0
Serpa	3,5	5,3	Évora	5,5	4,4
Estremoz	3,5	5,7	Vendas Novas	5,6	5,7
Mora	3,7	5,0	Vila Viçosa	5,6	4,4
Mértola	3,7	6,0	Avis	5,7	4,9
Montemor-o-Novo	3,8	4,7	Alter do Chão	5,7	6,2
Ferreira do Alentejo	4,0	6,2	Cuba	5,9	6,3
Grândola	4,1	6,3	Mourão	5,9	7,8
Sousel	4,1	6,5	Fronteira	5,9	6,8
Ponte de Sôr	4,2	4,6	Santiago do Cacém	6,9	6,5
Vidigueira	4,2	6,7	Castro Verde	7,9	4,1
Alvito	4,2	7,0	Castelo de Vide	7,9	4,5
Viana do Alentejo	4,3	6,0	Sines	8,2	8,1

Source: INE, Census 1991

With regard to the volume of the population that entered in each municipality of the Alentejo, we point out the municipalities of Santiago do Cacém, Castro Verde, Castelo de Vide and Sines as those where entry was more significant (7 – 8%) and those of Alcácer do Sal, Marvão and Moura, where the figures show that population entry had an extremely limited significance in the population growth between 1985 and 1991.

Balance of internal migrations in the municipalities of the Alentejo 1985-91

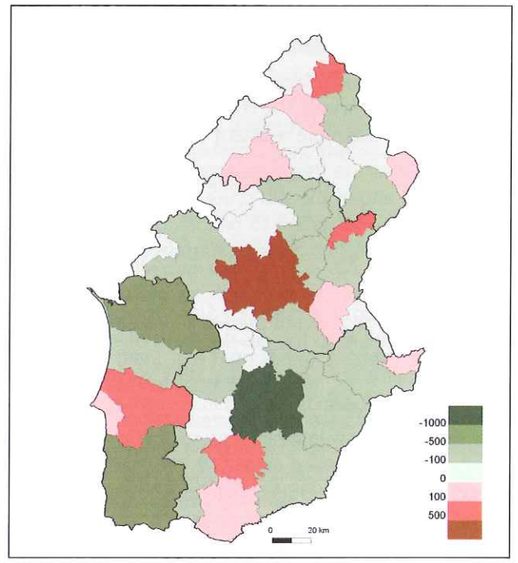


Fig. 7 - Source: INE, XIII Recenseamento Geral da População,1991

Figure 7 shows the information provided by the balance of internal migrations. Based on this map, it is possible to see that the majority of the municipalities of the Alentejo have a negative balance.

This negative balance is highly significant in the municipalities of Alcácer do Sal, Odemira and above all, in the municipality of Beja, where 1685 more persons left than entered the municipality.

As for the municipalities where this balance is positive, it is observed that in general, the excess of people who entered the municipality is very small (less than 50 persons). However, in the case of the municipality of Évora it is quite significant. This fact shows the big contrast in the behaviour of the cities of Évora and Beja, and the municipality of Central Alentejo, revealing a larger capacity to settle the population that relocates there.

Another observation is related with the municipalities of Santiago do Cacém, Vila Viçosa, Castelo de Vide and Castro Verde. Among these municipalities, Santiago do Cacém stands out due to the volume of population entry and exit flows. In fact, although the total number of people that moved are approximately 4200, the balance is only 112 persons.

This shows the municipality to have a large capacity for attraction, fundamentally for the population seeking to work in the area of Sines. However, it does not have any other type of potential to settle the population, since the exit flow is equally high.

In conclusion, this region is undergoing a process of depopulation and ageing, shown by low employment and income levels as well as by changes in agricultural practices, namely extensification or even abandonment of the agricultural land.

The population of the Alentejo tends to concentrate in the main urban centres, in the villages and in the mountains, where people and installations connected with the cultivation of large farms are found, thereby intensifying the cultivation of the land, many times related to pluriactivity, in the vicinity.

The Alentejo is a peripheral region seen from the analysed socio-economic indicators. Moreover, this peripheral socio-economic context is reinforced by a set of environmental features that do not favour the development of human activities in the region.

2.1.3. The *Alentejo Litoral*: Physical and Socio-economic Features

The physical conditions of the *Alentejo Litoral* are similar to those of the Alentejo. Nevertheless there are some differences, related mainly to the proximity of the Atlantic Ocean, which confers mildness to the climatic features. With respect to the landforms, the coastal plateau, which is covered by sand dunes and dominates the landscape, is limited to the inland by a range of hills *(Serra do Cercal and Serra de Grândola)* showing a more contrasting landscape with round summits, steep slopes and deep valleys.

Vegetation is dominated by the presence of the *Montado* oak plantation constituting an agro-forest-pastoral system of land use with two species of perennial oak: the cork-oak, common in coastal Alentejo and the holm-oak that dominates the interior of the region and is more resistant to extreme climatic conditions.

This land use system that permits the use of the trees (extraction of cork from the cork-oaks and the use of the acorn from the holm-oaks as animal feed) and of the sub-cover (for natural pastures, sowing, or cereal cultivation, depending on the density of the trees) was subjected to periods of excessive exploitation that, combined with adverse climatic periods (drought and abnormally high temperatures) led to the weakening of a wide area of the Alentejan oak plantation.

The coastline is defined by a sandy shore from the north of Sines to Tróia. This coastline obstructs the terminal section of various streams of the region, leading to the development of several coastal lagoons.

Otherwise, the coastline to the south of Sines is outlined by steep cliffs, carved in the parent rock (mainly composed by schists and greywackes), ravines, beaches, small islands, shaped in ancient and consolidated dunes, and isolated rocks.

Due to remarkable scientific and environmental interest, this section (almost 150 km long) of the Portuguese coastline, with the adjacent emerged and immersed areas (74 786 ha in addition 2 km large submerged strip parallel to the coastline), constitutes since 1988/1995[7], the Natural Park of the Southwest of *Alentejo* and *Costa Vicentina*. It is possible to observe an important diversity of landforms, which by its rarity constitutes singular records of its genetic origins (continental and sea planations as well as tectonic events) and it is an outstanding example of coastal landscapes evolution (Pereira, A. R., 1995).

Also the diversity of habitats (cliffs, dunes, islands, shrubs and moors) closely related with the parent rock and ocean vicinity, benefits the existence of a singular flora and fauna with high scientific value. Although it is mainly a rural area the pressure on this territory, mostly due to tourism activities, could damage the present environmental balance. These pressures result mostly from an unplanned territorial use, especially in what refers to the human settlement growth. It is possible to observe situations where the houses occupy areas next to the cliff border or even in the high beach.

The main problems of territorial management are related with:

- Intensive agriculture in more or less 2 000 ha (Irrigated Perimeter of Mira Basin) which lead to the extinction of some plant species;
- Marine and atmospheric pollution originated in the Sines Industrial Compound;
- Urban and seasonal tourism pressure over the coast;
- Inadequacy of some forestry projects;
- Random opening of access roads to the coastal zone;
- Illegal fishery and hunting;
- Arson and accidental fires.

[7] The Portuguese Southwest Coast is protected by law since 1988, year of the decree that creates the Protected Area of the Southwest of *Alentejo* and *Costa Vicentina* (D.L. Nº 241/88 from 7 June). However the singularity of the territory as well as the increasing human pressure and the need to preserve an almost wild region impel to the transformation of this protected area in a natural park by decree in 1995 (D.R. Nº 26/95 from 21 September).

Resulting from its geographic situation, landscape diversity and reduced human pressure the Portuguese Southwest Coast accommodates a rich natural patrimony that justifies the creation of the Natural Park of the Southwest of *Alentejo* and *Costa Vicentina* that aims at the preservation of the environmental balance of this territory. Therefore the Park is one of the factors of change that must be considered in the analysis of land use change.

However the present and the expected pressures can lead to the disturbance and destruction of coastal habitats, and also to the degradation of beaches by coastal erosion.

Socio-economic characterisation

The *Alentejo Litoral* (Fig. 8 and Annex 2), with a low population density (some municipalities have less than 20 hab/km²), has very irregular distribution reflecting both the differences that normally exist between the coast and the interior and the attraction of the industrial area of Sines.

Near the coast with medium-sized holdings, agriculture is characterised by the articulation between subsistence farming and farming which is more geared towards the market on account of the influence of the proximity of the industrial area of Sines.

The five main urban centres in *Alentejo Litoral* are the municipal capitals: Sines on the coast, Alcácer do Sal, Grândola, Santiago do Cacém and Odemira in the interior; Santiago do Cacém is traditionally the most active centre and the most important with regard to administration. The new town of Santo André has been created in connection with the development of the Sines industrial area.

In the last two decades, an increase in the total active population of Santiago do Cacém and Sines has been verified. This is explained by the development of the Sines industrial area. The opposite is true the municipality of Odemira, which registered a decrease. In the beginning of the 90's, this region registered an active population in the primary sector of 25%. Although the greatest increase took place in the secondary sector in the 70's, in 1991 it is clearly the tertiary sector that is predominant despite the industrial activities in the region.

With regard to the level of education, there is a high illiteracy rate (20% in 1991) and less than 25% of the population has reached more than the level of basic education.

The farm structure is similar in the five municipalities: the number of small properties of less than 20 ha is relatively high but the area occupied by these small units is minimal. They are concentrated on a fringe along the coast and in the county's two irrigated areas. The large farm units over 200 ha are a minority in all the municipalities but together they cover as much land as the medium-sized ones.

In general, the small units, located both in dry and irrigated areas, are farmed by their owners. Otherwise the large properties have mixed farming forms.

With regard to land use, most of the county's area is covered by *montado*, essentially with cork trees, with a more or less extensive use of the land. Along the coast and in the two irrigated areas, more intensive land use is possible, particularly for the production of vegetables and fruit.

Population Analysis

In terms of population, the high population densities of the parishes[8] of Sines and Santo André mark *Alentejo Litoral*. The parishes of Cercal, Santiago do Cacém and Vila Nova de Milfontes form a crown in the periphery of the Sines-Santo André axis that constitute the second most important area in terms of population. (Fig. 8).

The parishes that make up the chief towns are also an important focus of attraction of population. Aside from the above-mentioned municipalities of Sines (11 253) and Santiago do Cacém (6 039), the municipality of Grândola is extremely relevant due to the absolute number of its population: 9 357 habitants. The centres of Odemira and Alcácer do Sal appear to be divided into two parishes, which strongly contribute to the reduction of its relative weight for analysis in this NUT III.

A population nucleus larger than the whole of this NUT III is formed in the surroundings of the city of Sines. Included in it are the parishes of Sines, Santo André (the second most populated with 10 751 habitants), Cercal and Santiago do Cacém, totalling up to 32 220 habitants, which represents 33% of the residents of *Alentejo Litoral*.

The population of this nucleus of parishes has significantly increased in the 70s and 80s, which contrasts with the rest of the territory of NUT III. This signifies that, in evolutive terms, the resident population is marked by an approximation to the coastal area. However, this tendency is more clearly marked in the coastal parishes near Sines.

[8] The parish corresponds to the Portuguese smallest administrative unit: the *freguesia*.

Population density

Alentejo Litoral 1991

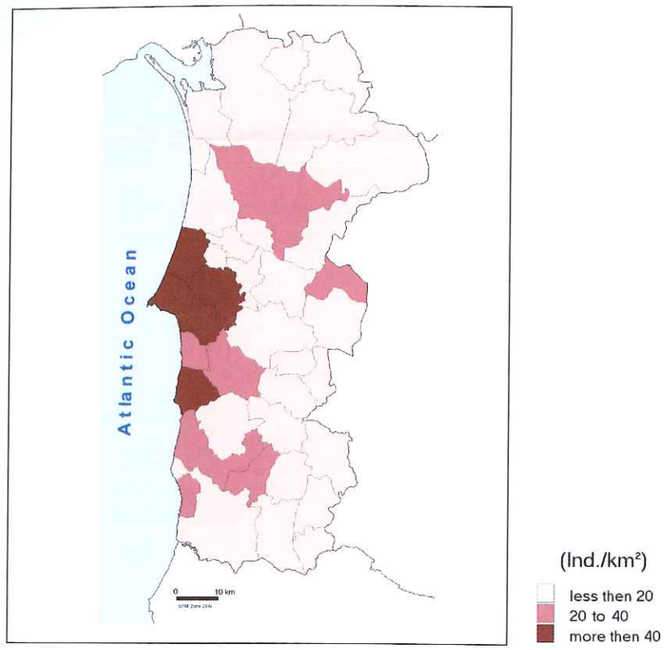


Fig. 8 - Source: INE, XIII Recenseamento Geral da População,1991

The Predominant Economic Activity

The parishes of the area of Sines are the most influenced by industrial activity, and this became more evident in 1991 (Fig. 9). The relative weight of the secondary sector dropped in practically all of the parishes of *Alentejo Litoral.* However, this generalised loss of influence made the industry of Sines even more important in the regional panorama.

If the 80's were marked by a reduction in the relative weight of the secondary sector, they were likewise marked by a substantial increase of the tertiary sector, which constitutes the predominant sector in all the chief town parishes. It is that the administrative function of the chief towns strongly influences the sector of activity of the residents of *Alentejo Litoral.* The fact that all the parishes that have contact with the sea have a tertiary sector weight of more than 30% is significant.

The primary sector continues to be an important employer, being in fact predominant in 4 parishes. The coastal area experienced a decrease, although extremely diffused, in the weight of the primary sector, which was particula significant in the parishes of Comporta and Porto Covo.

Pensioners and Retirees

Pensioners and retirees show a very well defined distribution in 1991, which is characterised by a predominance of the interior area of the NUT III to the detriment of the coastal area. Nevertheless, recent developments point to an increase in the weight of the retirees in the parishes closer to the coast (Fig. 10).

The existence of the population nucleus of Sines and adjacent parishes of this dimension as well as individuality at a regional scale, presupposes a certain dynamism in terms of land use, particularly through the advancement of artificial spaces, which in a certain manner could begin to be visible from the analysis of the variables of the General Census of the Population in 1991 relative to buildings.

Employment by sectors of economic activity

Alentejo Litoral 1981/91

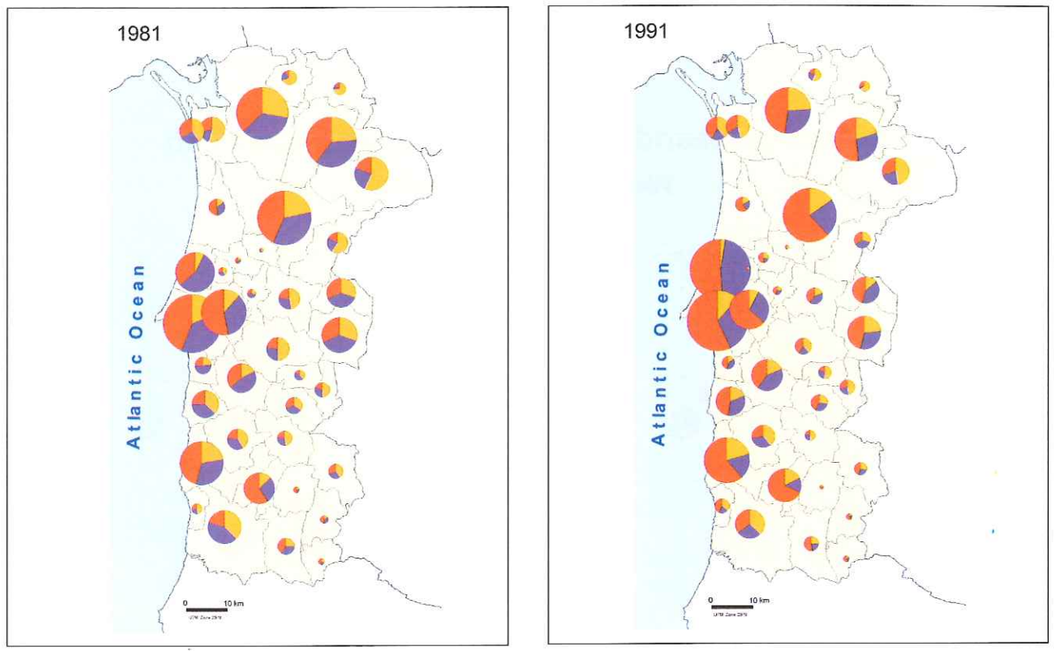


Fig. 9 - Source: INE, XII, XIII Recenseamentos Gerais da Populacão, 1981,1991

Buildings

The appearance of new buildings reveals a division among the more or less inhabited parishes (Fig. 11). Another possible approach would be the difference between the interior and the coast of this NUT III. When a parish has a high number of inhabitants and a coastal position, then we come across situations where most of the buildings were constructed after 1970 (the cases of Comporta, Melides, Santo André, Sines, Vila Nova de Milfontes and S. Salvador). Thus we can attribute part of the pressure that the area has experienced to a big potential for tourist attraction.

The question of tourist pressure is even more evident in the analysis of figures relative to new constructions (1985-91), for this highlights even more clearly the areas with a larger potential for resorts. The parishes of Vila Nova de Milfontes and S. Salvador[9] stand out because they register some 368 and 490 new buildings (when the average of this NUT III is 100) and at the same time, a density of new constructions of more than 2 buildings per km² (when the average of this NUT III is 0.8). To this category of parishes with more than 2 new buildings per km², we can add three more parishes deeply influenced by the tourism: Carvalhal, where the tourist complex of Tróia is located, Zambujeira do Mar and Sta. Maria.

The builded up after 1985 do not appear in the Survey Map of 1985. This is because, part of the urban pressure is very recent, not even being visible in the number of buildings in the 1991 Census.[10] However, between 1981 and 1991 there was a bigger tendency to construct new buildings, compared to the previous decade, as revealed in the global figures for *Alentejo Litoral* NUT III (from 6 578 to 8 197 buildings). The more significant exceptions are the parishes of Sines and Santo André, for having lodged the workers of Petroquímica, which mainly occurred in the 70's.

Pensionners and retirees and active population

Alentejo Litoral 1981/91

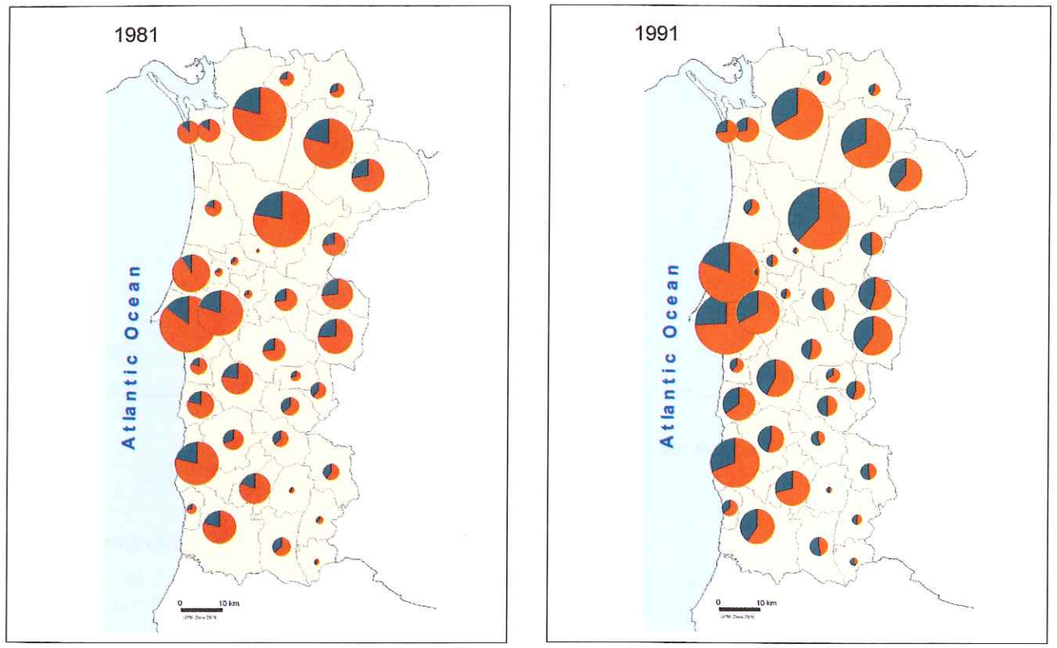


Fig. 10 - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981,1991

[9] Parish that lodges the municipal capital of Odemira

[10] See aerial photographs of 1995, ACEL.

Ageing

Based on the recent evolution of the age structure of the inhabitants of the parishes of *Alentejo Litoral* (1981-91) this population can be considered to be ageing (Fig. 12). However, this process is more evident in the younger ages, for the reason that only one (S. Bartolomeu da Serra) of the 38 parishes registers an increase in percentage weight of these individuals. Ageing at the base of the age pyramid is slightly more accentuated in the South of this NUT.

Pensionners and retirees and active population

Alentejo Litoral 1981/91

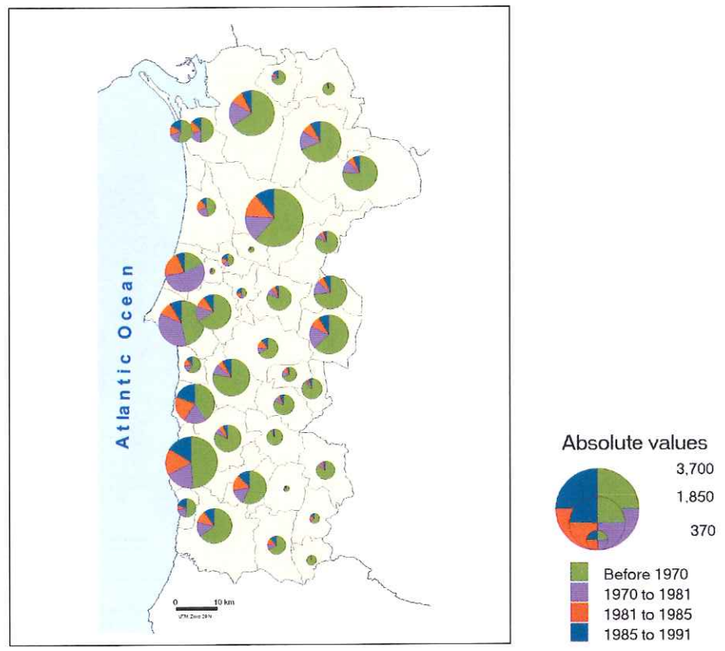


Fig. 11 - Source: INE, XIII Recenseamento Geral da População,1991

Agrarian structure

The land use in the farm holdings, in 1989, is marked by the high profile of the forest, specially in some parishes of the North of the NUT, particularly Sta. Maria do Castelo, Grândola and Melides (Fig. 13). The case of Melides is particularly significant in which forest occupies an area larger than the agricultural area. Taking into account agricultural cultivation, this forest surface is even more significant, which foresees its great influence in global terms in this area of *Alentejo Litoral*.

It is likewise in the north of the NUT III that the farmers have a higher level of education (Fig. 14). This is where there are fewer illiterates, a larger percentage of individuals having basic education and where two parishes with more than 3% of the farmers have secondary or tertiary education (Sta. Susana e Azinhaga dos Barros). A correlation exists between this educated population and the role of the forest in their activity. This line of reasoning is confirmed by the figures encountered in the two parishes of less forest activity in the North of the NUT (Comporta e Carvalhal), where more than 50% of the agricultural population is illiterate. That these two parishes are particularly significant for this study, englobing almost exclusively the most northern area at the regional level of study of the coastal area.

The North of *Alentejo Littoral* is an important nucleus of parishes with a younger agricultural population (Fig. 15). This group of parishes, essentially the parish of Alcácer do Sal, is located in an area where the population is more educated, and simultaneously the forest is the most representative land use. Issues relating to the orientation of subsidy policies could be at the base of these correlations.

Population ageing

Alentejo Litoral 1981/91

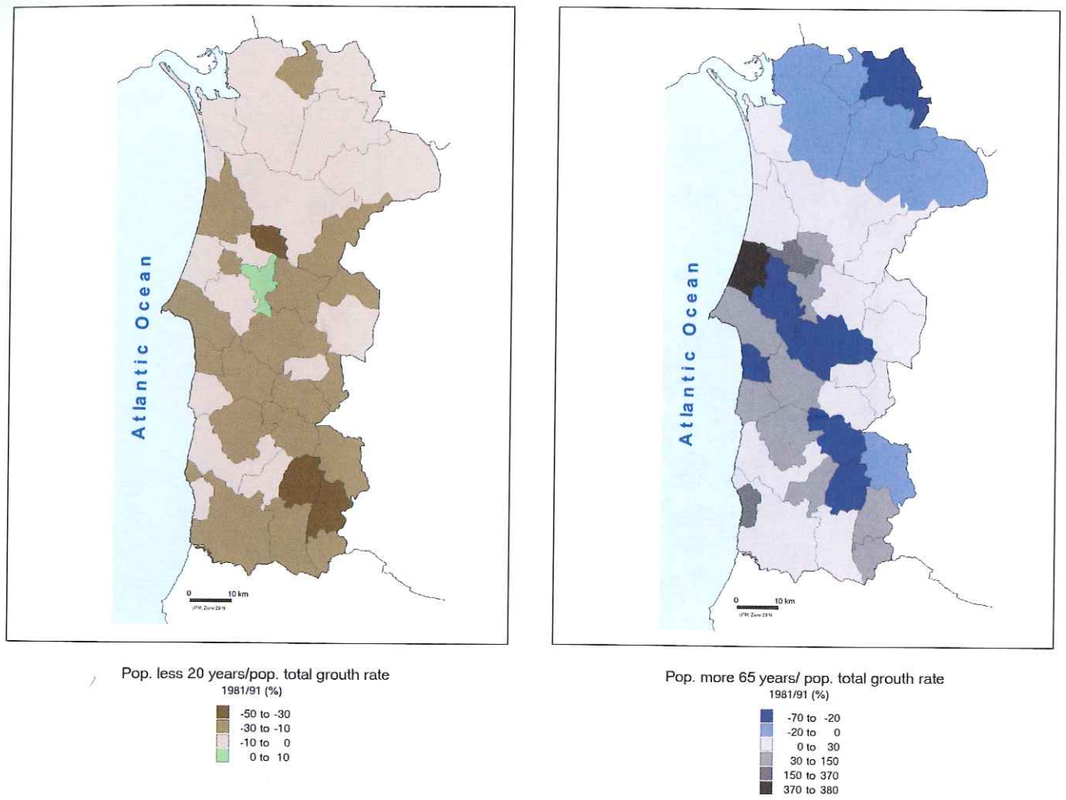


Fig. 12 - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981,1991

2.1.4. Institutional Drivers

In order to identify and understand the environmental problems of coastal zones, it is important to analyse the efficacy of the administrative structures at work, moving from the level of the formulation of the legislative framework, to its implementation, thus giving rise to an understanding of the influence of institutional dimensions at distinct levels.

Then, the main developmental strategic orientations of the region, without, aiming to cover the entire legislative body that influences, directly or indirectly, the area studied. The analysis of documents with territorial incidence shall be given priority, since they directly influence the occupation of the territory. Such is the case of those projects that, the dimensions and functions acquire a structuring character, such as the development project of Sines, the forest development plans, and large tourist enterprises proposed for the area studied.

Equally important however are the territorial planning and ordinance tools – with special emphasis on those that have powers at the regional and local level – in addition to plans in the energy, industry, tourism, agricultural, and forestry sectors that fit into the framework of the strategic development options of the region.

Land use in agricultural farms

Alentejo Litoral 1989

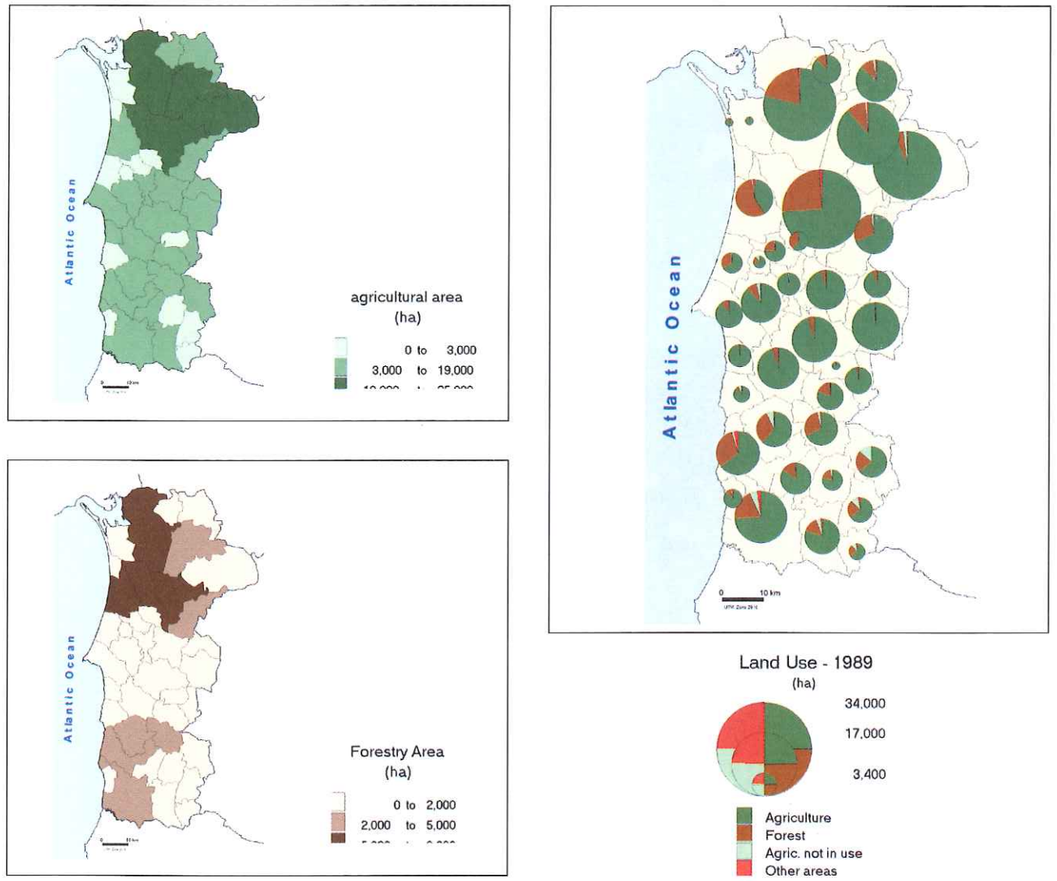


Fig. 13 - Source: INE, II Recenseamento Geral Agrícola,1989

Planning and Ordinance Tools of Coastal Zones

The urgent need for territorial planning and ordinance has existed prior to 1974. However, with the democratisation of the political system in Portugal, these needs have become addressed in a more concrete manner through the definition of territorial planning and ordinance tools and the protection of natural resources.

Improper land use, in the coastal zone of the Alentejo, existed prior to the 80s,with serious consequences for the environment. But the specificity of these problems have been the subject of planning, ordinance and natural

resource protection tools only following the integration of Portugal into the European Union, in the mid-eighties. In fact, the institutional framework is in part a reflection of problems and needs at the European and international level.

Head farmers intruction

Alentejo Litoral 1989

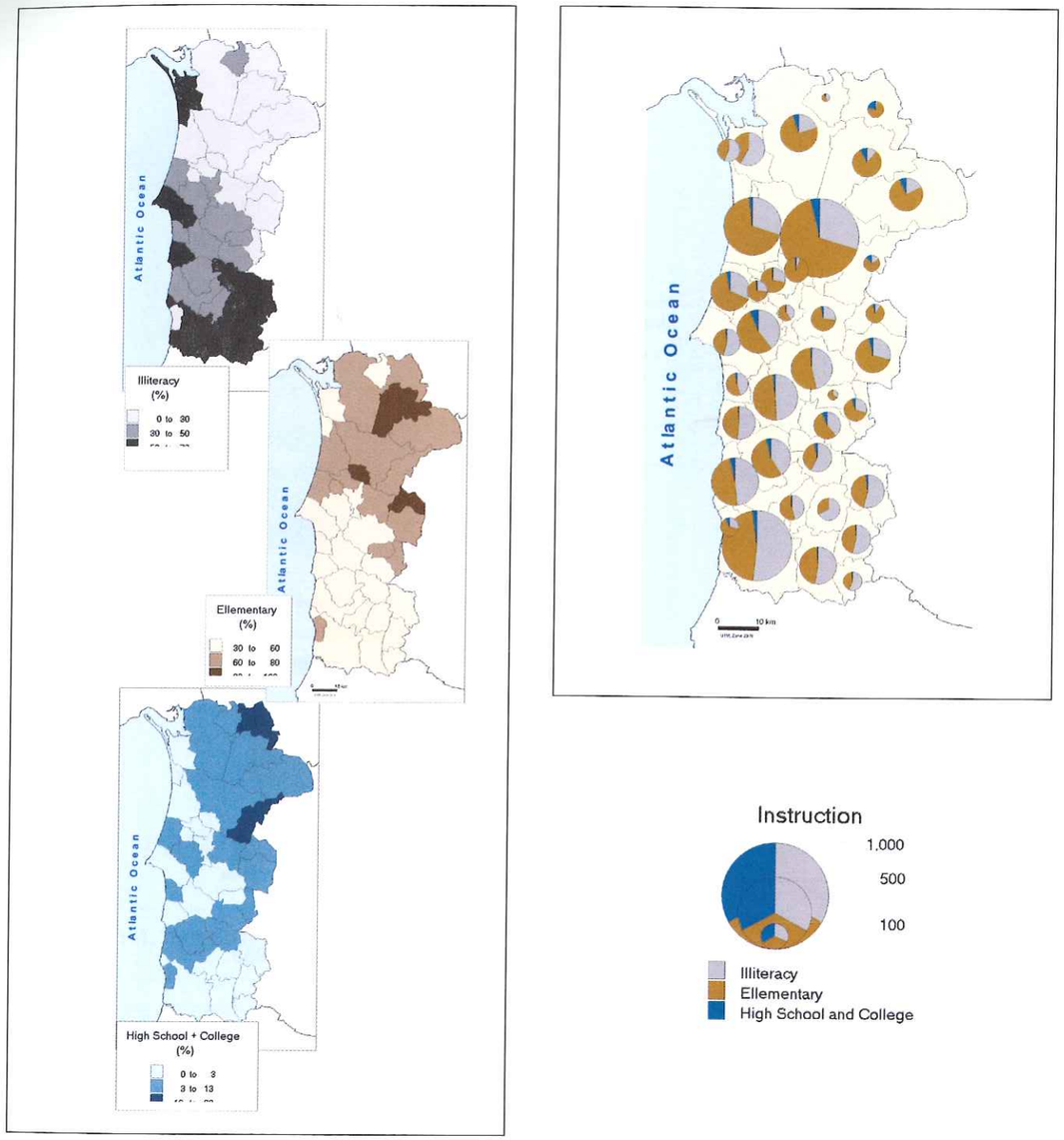


Fig. 14 - Source: INE, II Recenseamento Geral Agrícola,1989

Head farmers by age groups

Alentejo Litoral 1989

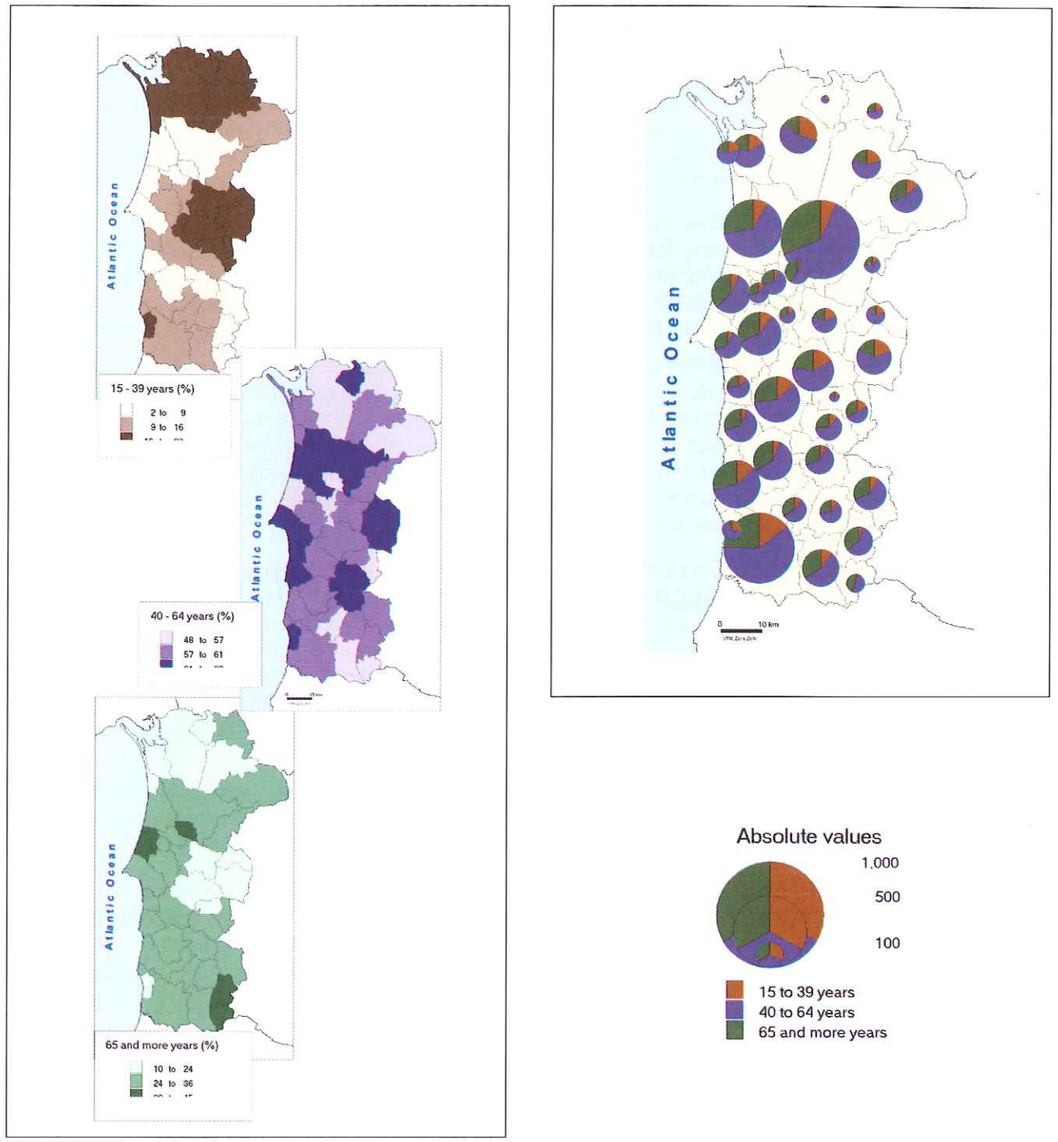


Fig. 15 - Source: INE, II Recenseamento Geral Agrícola, 1989

In Portugal, the responsibility of management of coastal resources is shared by several administrative structures that intervene at different spatial levels (national, regional and local levels). This presents some conflicts of interest, due to the contradicting objectives of the planning tools, which make up those administrative structures.

The approach to the study of institutional aspects makes possible the assessment of the degree of adaptation of the Portuguese legal framework to the huge pressures felt over the coastal zones, mainly in relation to environmental preservation.

The planning tools are: Territorial Regional Ordinance Plans (*Planos Regionais de Ordenamento do Território - PROT*), Municipal Master Plans (*Planos Directores Municipais - PDM)* and Coastal Border Ordinance Plans *(Planos de Ordenamento da Orla Costeira - POOC*).

There are various planning tools whose scope is Coastal Alentejano, such as: a zoning ordinance plan, five municipal master plans, two coastal fringe ordinance plans, and a protected area ordinance plan. It must be noted that the planning tools described refer mainly to the period concerning the CORINNE and LACOAST projects (1975-1985). They were therefore not yet in force in the period that applies to this study. Hence, we focus on the problems that constitute the subject of formulation of regulations, since these frequently result from the survey of situations of degradation observed in the past.

Regional Territorial Ordinance Plans (*Planos Regionais de Ordenamento do Território* - PROT) are tools of a programmatic and normative character, drafted by regional co-ordination commissions, structures that report to the Ministry of Territorial Planning and Administration. These plans contain defined rules regarding urban and industrial expansion and defined areas that are sensitive and of environmental (REN – National Ecological Reserve or *Reserva Ecológica Nacional*) and agricultural (RAN – National Agricultural Reserve or *Reserva Agrícola Nacional*) interest.

The scope of the Regional Ordinance Plan of the *Alentejo Litoral* (PROTALI) includes the municipalities of Alcácer do Sal, Grândola, Odemira, Santiago do Cacém and Sines. It was ratified in 1993. The PROTALI contains guidelines for the development of the Sines port-industrial complex and coastal tourism. It harmonises these two components with the development of port and road infrastructures, the protection of the environment and natural resources, and reinforces the complementary aspects of the Coast with the Alentejo Region. Among other specific objectives of this plan there are pollution and environmental degradation control in general, allowing for the development of tourism and activities supported by the exploitation of natural resources.

Municipal Master Plans (*Planos Directores Municipais* - PDM) are drafted by local governments. They are territorial administration tools that regard the use of the land of the Municipality. These planning tools are created with the objective of providing local governments with greater dynamism and responsibility. The PDM locally expresses a development option in favour of controlling territorial planning, defending and valuing natural and human resources, seeking to assume a perspective of integrated development[11]. In such a manner, a classification of land and urban indexes is established, taking into consideration the rules for urban and industrial expansion, the objectives for development, the rational distribution of economic activities, the lack of housing, equipment, transport and communication networks, and infrastructures.

Among the municipalities identified in the studied area, Alcácer do Sal, Grândola, Santiago do Cacém, Sines, Odemira, only the last had not yet ratified its PDM at the end of 1998. Since 1990, the mandatory character of these plans implies the application of sanctions for the municipalities that do not comply.

Coastal Border Ordinance Plans (*Planos de Ordenamento da Orla Costeira* - POOC) arise from the need to save valuable nature and landscape of the coastal fringe, and from the recognition that the coast, the coastal fringe, in particular, is characterised by an environmental sensitivity and a wide range of uses.

These plans apply to marine waters, interior ranges, and respective beds and banks, with land protection bands with widths not exceeding 500 meters from the line that separates the waters from the sea bank, and a shore that has a maximum bathymetric limit of 30 metres.

The objective of the Coastal Border Ordinance is the ordinance of the different uses and specific activities of the coastal fringe, the classification of beaches and bathing regulations. It also defines rehabilitation and requalification measures of degraded coastal zones, such as the qualification and appreciation of beaches considered strategic for environmental or tourist purposes. It orients the development of activities specific to the coastal fringe and the defence and conservation of nature.

They are normative and guiding tools in the use of beaches and the land protection area, defining the capacities of beaches and regulating beach support in the area of maritime public jurisdiction. In this manner, they play an important supporting and regulating role of tourism and related activities, such as leisure and recreation activities.

[11] This plan is graphically represented by the ordinance map and by the updated regulations map: the first demarcates classes of spaces according to the dominant use and establishes management and planning operatives, the second indicates the administrative rights of free passage and public utility restrictions, including those that occur in the National Agricultural Reserve and the National Ecological Reserve.

Nature conservation areas and watersheds

Alentejo Litoral

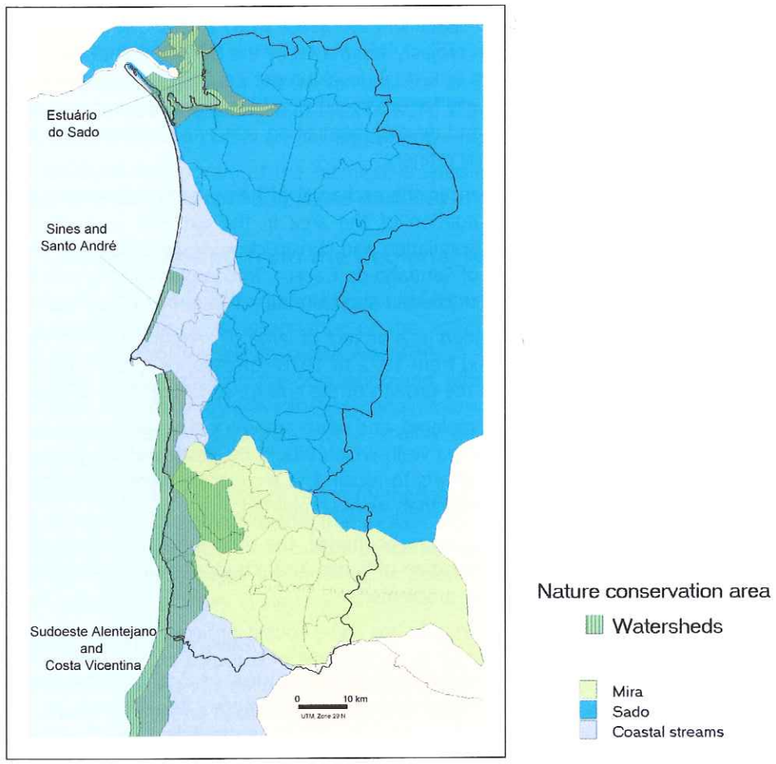


Fig. 16 - Source: DGRN, Atlas do Ambiente, 1989

In the case of protected areas, the responsibility for drafting POOCs falls on the Water Institute (*Instituto da Água*) or the Nature Conservation Institute (*Instituto de Conservação da Natureza*), these being under the Ministry of Environment. Both ordinance plans of the Alentejo coastal fringe, cover the areas from Tróia to Sines that fall under the responsibility of the Water Institute (*Instituto da Água*) and from Sines to Burgau that fall under the responsibility of the Nature Conservation Institute (*Instituto de Conservação da Natureza*) (Fig. 16). These plans override local and regional plans. They were created to avoid situations of urban pressure and to promote coastal protection efforts. Two beaches with a high environmental value were identified under this plan: the Aberta Nova beach (Grândola) and the Monte Velho beach (Santiago do Cacém), where recuperation and valorisation projects are being carried out. The most immediate consequences of the classification referred are, in the first case, regulated bathing, and in the second case, the prohibition of all types of equipment given its ecological fragility.

An Ordinance Plan for a Protected Area may come in two forms, depending on its national, regional or local scope: national parks, reserves and natural parks, and protected landscape.

The natural park is defined as a space that contains natural, semi-natural, and man-made landscapes with national interest. An example of which is the harmonious integration of human activity and Nature, which manifests patterns of a biome or natural region. The natural reserve is defined as an area designated to protect habitats of flora and fauna, while protected landscapes are defined as areas with natural, semi-natural, and man-made landscapes, of regional or local interest, resulting from the harmonious intervention of Man and Nature and manifesting great aesthetic or natural value.

In the region of Alentejo Coastal, there is an Ordinance Plan for the Natural Park of Southeast Alentejo and the Vicentina Coast, the limits of which are represented in figure 16. It partially covers the municipalities of Odemira and Sines, in the region of the Alentejo, and Aljezur and Vila do Bispo, in the region of the Algarve. This Natural Park w s created in 1995 and prevented the occupation of areas recognised to have environmental importance.

Development Projects of a Structural Nature

The main Coastal development project, with direct spatial impact on the study area and with consequences for the period analysed, is based on the area of Sines. This project, designated by the Development Plan of the Sines Area, was elaborated in the early seventies to create an industrial development area in the region south of the Tagus. The option for Sines, aimed to counter the tendency for urban-industrial concentration in the area of Lisbon and the Setúbal peninsula, through the construction and development of an concentrated area with basic industries, grounded on the development of a barbour and oil refinery.

The barbour was intended as an important element in the exchange of heavy cargo from various origins and to various destinations, taking advantage of the situation of the area in the extreme west of Europe and the intersection of long distance routes. The area of installation and construction of infrastructures covers the whole municipality of Sines and part of the municipality of Santiago do Cacém. To complement the development project of Sines, a new city, Santo André, was planned and created approximately 10 km from the industrial area.

The industrial complex, having initially been designed as a project of large dimension, suffered the effects of the oil crisis of the early seventies. Although the period from 1972 to 1978 corresponds to the construction phase of the port, the economic crisis explains the limits to the growth of the enterprise falling short of initial expectations.

In 1978, when the construction of the port was completed, and when commercial activities were initiated, a strong storm caused significant damages in the western sea wall, which would be destroyed the following year by an equally violent storm. Between 1980 and 1985, efforts to repair and recuperate were carried out and the land infrastructures that permit the operation of main terminals were completed.

In 1990 the port terminal, the refinery, the petrochemical complex, the thermoelectric power plant of Portugal Electric (*Electricidade de Portugal*), and the agglomeration of Santo André had a population way below what was expected and numerous urban and socio-economic problems[12].

Among the development projects of a structural nature are some tourist projects such as the project of Tróia, initiated in the early seventies. Frequently referred to as an example of a tourist project with serious impact on environmental quality, this project faced serious financial difficulties for which a financial group with private capital presented a reclaiming and requalification plan in 1998. The increase in urban pressure in Tróia is already evident in the recent approval of 15 thousand beds, seven times the number of existing beds, a golf course, and a marina with a recreation port, under the structural project criteria for the development of the region, in conflict with the limitations imposed by PROTALI and other ordinance plans.

The presentation of investment projects that counter the main guidelines of PROTALI causes conflicts among financial agents and the entities responsible for the implementation of the plans. For instance, the strong pressure of financial agents for the construction of tourist ventures at the Aivados beach and in Pinheirinhos has been, in the recent years, subject to the limitations imposed by these plans. However, seeking solutions to facilitate investment and economic growth, the PROTALI defines Tourist Nuclei based on the upgrading of existing tourist projects, trying to conciliate criteria of preservation and development and to respect commitments made by the central or municipal government.[13]

Tourist activities are a driving force essential to understanding land use changes in coastal zones. The strong pressure for the expansion of urban areas and other tourist areas (recreation and leisure areas) contribute to the degradation of environmental characteristics, limiting the development of tourist activities themselves in the future.

Making Investment Projects and Planning Tools Compatible

The proliferation of plans and authorities among the diverse State institutions and local governments has been replacing the absence of planning characteristic of the previous decades, particularly after Portugal joined the European Union. However, in practice it areates problems and conflicts difficult to resolve. Despite the existing

[12] New development plans for the Port of Sines were carried out. At present, transport infrastructures, considered part of a strategic option of the Integrated Development Program of the Alentejo (PROALENTEJO), are being built.

[13] The PROTALI divides Coastal Alentejo in seven Ordinance Units and respective Tourist Development Areas, and four Tourist Nuclei with quantitative limits to tourist use.

hierarchy of powers and authorities of plans, in reality, the division is not clear and it generates conflicts among the various institutions involved, questioning the capacity of intervention of public powers. One of the most frequently used examples are the urban expansion areas defined in the PDMs that are included in the 500-metre band from the sea and are subject to POOC norms.

The problems in the application of measures of the various planning tools result, on the one hand from the difficult co-ordination among them and, on the other hand, from the lack of application of some of these measures. The absence of fiscal measures, the impunity of agents, and indifference in the protected areas, such as the areas of the Agricultural reserve and Ecological reserve, are factors that contribute to the problem.

The diversity of entities responsible for the implementation and application of the plans, whether at the level of central power, or at the level of regional and local powers, likewise causes some difficulties in co-ordinating the various planning tools. These difficulties are still aggravated when there are conflicts of interests of these entities.

The Integrated Development Program of the Alentejo, created in 1997, seeks to address some of the aforementioned difficulties, defending a form of global and concerted intersectorial action for the entire Alentejo Region.

2.1.5. Questions arising from the Regional Analysis: the main societal driving forces

Since 1970, the Alentejo has been undergoing a process of depopulation and ageing of its population. At the same time, there is a strong decrease in importance of the activities in the primary sector, accompanied by the reinforcement of the weight of the tertiary sector, essentially of a social nature. This is a region where the absence of economic activities capable of fixing the population and, alternative to agriculture is forcing the population to leave for other regions of the country. Nevertheless, certain municipalities in the *Alentejo Litoral* (Sines and Santiago do Cacém) reveal some capacity to attract labour, mainly due to the economic dynamism stimulated by the industrial pole of Sines.

The regional analysis within the framework of the methodology put forward allows the identification of the main changes as well as the most important factors that explain them in the analysed region. Hence, the main result of the regional analysis previously presented consists in the identification of the processes of change and the main driving forces behind these processes, with emphasis on Coastal Alentejo: industrialisation, urbanisation as a result of the increase of population pressure in industrial areas and in areas with tourist activities and agro-forestry activity.

Processes of change in the Alentejo

Industrialisation as a driving force is characterised by the growth of a harbour and industrial pole, which, without being anchored on a continuous process of economic development and implemented in a manner sustained by the socio-economic characteristics of the region, corresponded to a temporary project, vulnerable to changes in the international economic context. The oil crisis in the seventies, and its effects on the European and world economy, led to changes in the project, initially taking into account a combination of factors characterised by the low price of oil and the availability of energy resources originating from Portuguese colonies.

The main effects of this project in the use of the land has been quite limited to the area of Sines, particularly with the construction of the port and industrial area, and the urban agglomerate specifically created to answer to the housing needs of the workers attracted by the venture–Cidade de Santo André.

Urbanisation is a driving force in Alentejo's coast. It results from the population pressure, attracted by the port and industrial area of Sines and by the growth of some urban agglomerates with the largest potential for tourist development. If the former type of urbanisation is clearly identifiable in the period analysed, the latter corresponds to a more recent process, and in some agglomerates, beyond the period for which socio-economic data in official statistics are available.

Urbanisation is characterised by the increase of population density and consequently, the growth of the area constructed for habitation and infrastructure development and collective equipment in response to the needs of the population. The increase in importance of the active population in the tertiary sector in this region likewise reflects the dynamics of urban growth.

While agricultural and forestry activities are losing significance in the context of the region, they are quite important in the socio-economic dynamics of Alentejo's coast. The relative weight of the population in the primary sector in the region, with employment in agriculture, cattle-raising, and forestry, is still significant. If retired people still involved in agricultural activities are added to the active population, the weight of this sector is still very significant (Lourenço et al, 1997).

The extensive system of agro-forestry production dominant in the region is characterised by low levels of investment in production factors – particularly in terms of labour-, having little employing power at the base.Thissystem could still evolve in the direction of the reinforcement of forestry activity which has a reduced need for labourforce.

2.2. Coastal Zone

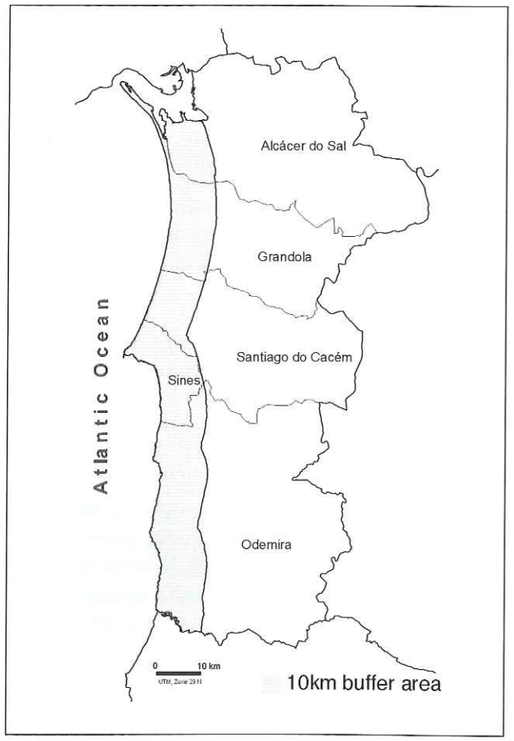
2.2.1. Identification of the Coastal Area

The territorial unit of analysis in this study is the coastal zone of the *Alentejo*. This area consists of a 10 km-wide band, stretching along the coastline (Fig. 17). The estuary of Sado River borders it to the north and the Odeceixe River, to the south. Another significant river in this area is the Mira River that crosses this coastal strip to the south of Sines.

Especially at the north of Sines the landscape of this coastal area, is also marked by the presence of several lagoons that result from the geomorphologic evolution of the coastline. The Santo André lagoon stands out due to its dimension.

The study of this territorial unit is conditioned by the availability of information. In fact, the primary source of data was the project Land cover Change in European coastal zones - LACOAST[14], which consists of the inventory of land use / land cover changes obtained from the comparison of the CORINE Land cover (CLC) database of 10-km from the coastline of ten European countries.

Fig. 17 – Coastal band of the *Alentejo* studied



The fixed extension of the coastal zone compels a broad analysis of land use dynamics resulting from nature-society interactions in coastal areas. The impacts of the socio-economic and environmental changes present in coastal areas can eventually be identified in areas far from the coastline, beyond the established 10 km.

[14] The Lacoast project was launched by the Agriculture and Regional Information Systems (ARIS) unit of the Space Applications Institute of the Joint Research Centre, and was funded by the Centre for Earth Observation (CEO) programme Workpackage AS3200 (Application projects in support of the European Commission Services).

2.2.2. Data Collection and Treatment

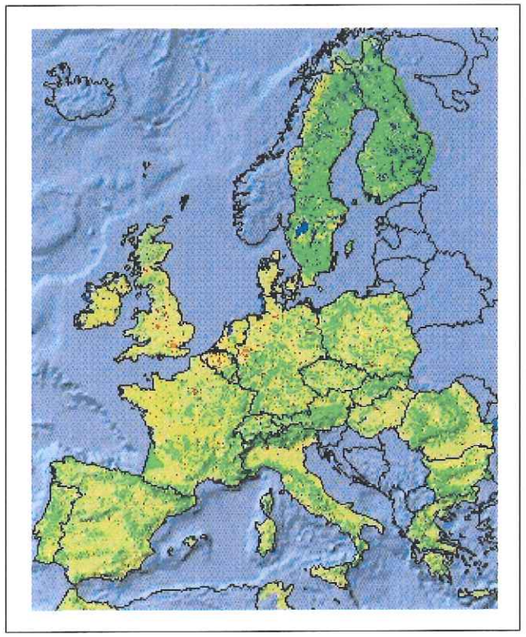
To reach the main objectives of this phase of the analysis it was necessary to collect data on land cover and socio-economic traits of the population of coastal Alentejo.

Data Collection

Biophysical Data: Land cover

The land cover data available with the Lacoast project, is based on a comparison of information obtained from satellite images and ancilliary data, is based on CORINE Land cover database (Fig. 18), which, for Portugal, refers to 1985 and Landsat images from 1975. This data was an important effort to make a quantitative assessment of land cover/land use changes in European coastal zones, especially due to human activities.

Fig. 18 - CORINE Land cover in Europe



Source: European Environment Agency http://etc.satellus.se

The land cover data corresponds to digital maps (scale 1:100 000) obtained from satellite images (1975, Landsat MSS[15]; and 1985, Landsat TM[16]) produced by CNIG (*Centro Nacional de Informação Geográfica*). The legend that served as a basis for the definition of the 1985 and 1975 land cover polygons is the same. The 1975 land use cover was carried out after 1985 but based on the previously defined standardisation. We also made an effort to work with similar margins of error. Nevertheless, the fact that they are, in origin, satellite images with different resolution, limited the identification of land cover changes.

Socio-economic Data

The socio-economic data were taken from the Population Census of 1981 and 1991. It was introduced in this analysis, after place / square kilometre area conversion also supplied by CNIG, after permission for its usage, by the Portuguese Statistical Institute (*INE*).

[15] Landsat Multi Spectral Scanner 1975 - 80m resolution.

[16] Landsat Multi Spectral Scanner Thematic Mapper 1985 –30m resolution

As for the regional analysis of the 10 km² coastal strip, data was selected from the INE General Population Censuses of 1981 and 1991 and divided into small squares of 1 km². This grid was made by CNIG, using the information of the INE Census. The work carried out by CNIG consisted on the creation of a 1-km² square for all of Continental Portugal, to which the INA alphanumeric data, disaggregated at the level of the place,[17] was geo-referenced. This operation resulted in a discontinuous grid consisting of 1-km² squares, given the absence of places in all the 1-km² parcels of Continental Portugal. For the socio-economic analysis of the coastal zone, squares located less than 15 km from the coastline were used.

This square shows the socio-economic characteristics of the population, such as the resident population, the present population, the age structure, the level of instruction, the sector of economic activity, and inactive population. For buildings, data on the year of construction, characteristics of the main resistant element (concrete, wood, etc.), and living conditions of housing, were collected.

Ancillary Data

Since the biophysical aspect is at the base of this project, complementary information was likewise collected: aerial photographs of a scale of approximately 1:40 000 taken from an ACEL (Association of Cellulose and Paper Producers, now called CELPA[18]) flight in the summer of 1995, and biophysical elements of the 1:25 000 Topographical Maps. Although these elements were not geo-referenced, they served as a complement to the analysis carried out, being part of the multimedia dimension of this GIS.

The data on the institutional dimension allowed the identification of certain public utility restrictions in the area, taking into account these limitations on the land use change.

The socio-economic, biophysical, and institutional data was collected mainly in order to meet the global needs of pluridisciplinary integration. This information contributes to the understanding of the impact of human activity on the territory, and likewise, it must reflect the biophysical changes in the socio-economic dynamics. The integration of the institutional component in the GIS is consistent with the possibility of adding a spatial aspect to management measures.

The Geographical Information System

The data collection and treatment was necessary to implement a pluridisciplinary GIS for the integrated analysis of land cover and use. The construction of this GIS permits us to reach the objectives of integrating biophysical, socio-economic, and institutional data.

The Operation of the GIS: The Basic Functions of the GIS

The constitution of the GIS was preceded by a set of questions that provided a framework to fit the study of land use changes in the coastal zone of the Alentejo:

Should the analysis encompass areas where significant changes are identified?

What are the socio-economic dynamics associated with the land use changes?

How can the institutional aspect be integrated into the analysis?

What are the levels of analysis to be adopted?

The answers to these questions constitutes a starting point for the construction of a GIS that seeks to relate biophysical, socio-economic, and institutional dimensions, to detect the processes of land use change. Possible answers to these questions have emerged from the case study carried out. In fact, the structure of the GIS itself (Fig. 19) provides already indications regarding the adaptation which was necessary for the *socialisation* of the GIS.[19]

As for the relation between the socio-economic and biophysical data, there was an attempt to connect the data[20], whenever the disaggregating of data permitted, in order to discover relations that sustain the hypotheses explaining change.

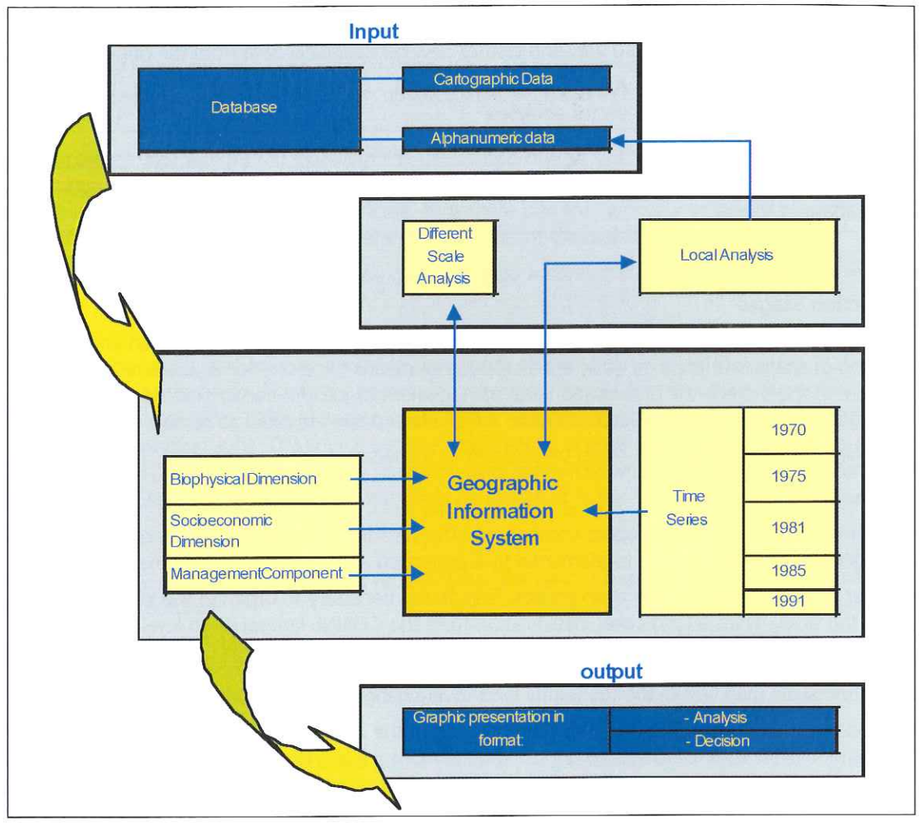
[17] Place, as defined by INE in 1991, as "the entire group of adjoining or neighbouring buildings, with ten or more quarters, to which a designation corresponds. On a spatial level, the concept encompasses the surrounding area where support services are found (school, church, etc.)"

[18] National Association of the Paper industry (*Associação Nacional da Indústria Papeleira*).

[19] See section 1.1.4 - Socialising the GIS

[20] The operation "linking people and pixels" (Entwisle, 1998).

Fig.19 – GIS developed to operationalise the study of land use changes



The importance of GIS in the study of land use changes

GIS has the advantages of being functional and communicative, hence its use has become fundamental in integrated studies. It constitutes a tool that permits the association of geo-referenced information, respectively graphical and alphanumeric, with different attributes, entities and volumes. The GIS allows a whole set of data analysis operations spatially referenced at various scales, which constitutes one of the main fundamental principles of the methodology presented in this work.

The constitution of a geo-referenced database with information collected should render possible the association of biophysical and socio-economic data and their intervention at different levels of analysis, this being one of the main objectives in using the GIS in this study. What makes these GIS even more pertinent is the fact that they permit the construction of dynamic models of geographic reality (Martin, 1991) that makes it possible to reach alternative representations for the production of information to support decisions.

In effect, the use of these *socialised* GIS has already been defended in previous studies (Lourenço *et al*, 1997 and Lourenço, Jorge and Machado, 1997) as indispensable tools in monitoring land use and land cover dynamics. Aside from the characterisation variables of the various intervening actors in a certain territory, *socialised* GIS, when associated to adequate techniques of sociological analysis, permit the integration of information relative to attitudes and expectations. In this manner, they become essential tools in the construction of systems that monitor and assess political impact, which constitutes the guiding objective of the methodology proposed here.

The functions to be carried out by a GIS of this type are defined in accordance with the applications needed. In this concrete case, there is the need to interact with software capacities (Table 3), the information introduced, and the necessity to carry out operations of analysis in order to attain the objectives of the study.

Table 3 – Software Resources Used in the Study

ArcView 3.1 – Desktop Geographical Information System (GIS), organises the alphanumeric and cartographic data using specialised databases. Responds to questions of a spatial nature in an integrated way and creates new geographical data from the original data.
Spatial Analyst – Raster Analysis creates, inquires, maps, and analyses raster data and carries out integrated raster-vector analyses.
Microstation 95 – Vectorial Graphics Editor, to correct the cartographic data.
Excel 97 – Calculation Worksheets serve as support for the tables to be integrated into the database of the GIS.

GIS Construction Stages

When we talk about GIS, we refer to three basic principles used as a guide in its construction and use: the storing and integration of spatially referenced data; the availability of means necessary for analyses related to the pluridisciplinary nature of the project; the organisation and management of information in order to make it easier to use, or in other words, the information structure must be accessible and open in order to be able to integrate new data.

The main stages in constructing a GIS could be outlined as follows:

Data Treatment

Data treatment refers to the cartographic component. The necessity to spatially reference the data makes the necessity of geographical referencing fundamental to a projection and a system of coordinates.

The land cover data was used in three main phases. First, it was necessary to organise the legend according to the objectives of the study. Thus, a land cover classification from the CORINE legend (third level) was taken.

Then, this vectorial information was rasterised, constituting a grid of pixels with a coverage resolution of one ha.

Finally, a mathematical map was made to identify land cover changes.

As for the socio-economic data, the first step was to integrate the information into the Geographical Information System.

The second step was spatial referencing, departing from the lower left corner of the kilometric grid.

As for the socio-economic data, the first step was to integrate the information into the Geographical Information System.

The second step was spatial referencing, departing from the lower left hand corner of the kilometric grid.

Regarding the treatment necessary for the integration of alphanumeric data, it is useful to mention the importance to create unique identifiers so that they can make correct links to the elements.

Data Integration

The GIS makes it possible to link or to integrate information that is difficult to associate through any other means. Thus, a GIS can use combinations of mapped variables to build and analyse new variables.

First, the data was graphically edited in order to make it compatible (Table 4). When working with different fonts and scales, this is an essential procedure in adjusting the data, allowing for its interpretation. An example of this is the necessity to adjust limits of land cover to roads or waterways.

Table 4 – Operations for Information Integration

1. Edition of cartographic and alphanumeric information
2. Change of map scales
3. Geographic referencing in accordance with the projection and system of coordinates
4. The importance of the layout in the integration of information not geo-referenced.

The most important procedure of alphanumeric data edition is the adaptation of the place definition criteria of INE. In 1981, INE considered all places separately, even when they adjoined urban agglomerations.[21] In 1991, the population agglomerates adjoining urban centres were integrated in a single place, thus limiting all the geo-referenced information to a single pixel of the grid. The comparison of the two analyses was only possible with the compatibility of the 1-km² squares of socio-economic data. The adaptation made in the study consisted of the grouping of places/1 km² squares contiguous to the 1981 urban agglomerates, in order to concentrate all the information in one single point. The operation consisted of an adaptation of the 1991 place determination criteria to the data in 1981.

Another example of data integration operations is the comparison of two sources of information that represent the same reality with distinct scales (Fig. 19), with a level of different desegregation. In this case, the limits of the various administrative units do not always coincide, thus there was the necessity to graphically adapt the limits of Alentejo (NUT II) to the greater degree of detail in the parishes of Coastal Alentejo (NUT III).

In the integration of cartographic data, the reading of each map according to the original projection was carried out (Table 4). Afterwards, a projection and system of coordinates was adapted, to which all the maps were transformed.

The layout, or in other words, the final composition, took on an important role in the integration of non-geo-referenced data. The layout was seen as a way of developing multidisciplinarity, to the extent that it allowed the integration of non-geo-referenced data in the analysis. For example, the GIS formed only includes two events of land cover, the most recent refers to 1985. However, there was a necessity to complement this information, with data relative to 1995 aerial photographs. This source became fundamental in order to compare the changes identified with the most recent period (1995). In the same way, identified from socio-economic data, areas of significant change that did not reflect in 1975/85 land cover changes, but could be identified in the 1995 photographs.

Data Structures

Since digital data were collected and stored in various ways, the various data sources were not entirely compatible and convertion was necessary.

The CORINE and LACOAST data originated from satellite images were converted by the GIS into a vector structure by generating lines around all cells with the same classification, while determining the cell spatial relationships, such as adjacency or inclusion. In this way, the land cover data changed from a raster data structure to a vectorial structure that constituted the base of work.

In order to speed up the processing and make it more adapted to the quality of Landsat satellite images on which they were based, the vectorial structure was converted into a raster structure with a pixel of one ha.

The socio-economic and institutional information was worked on in vectorial format, referenced onto a grid of one km². Although this grid was initially created based on raster data structure principles, the high volume of socio-economic data rendered it too complex to be supported by this structure. This explains the use of a vectorial structure.

Data Modelling

Data modelling is one of the most interesting forms of data use in GIS since it is fundamental to obtaining the results (Table 5).

Table 5 – Results obtained with GIS based on data modelling

1. Demographic features
2. Land cover features
3. Land cover evolution
4. Identification of hotspots[22]
5. Analysis of the surroundings of hotspots
6. Crossing of biophysical and socio-economic data

[21] Using this definition, the urban perimeter of a city or town can be determined in the grid.

[22] At this point, areas with more significant dynamics were considered hotspots.

The simplest form of original data modelling allowed the characterisation of biophysical and socio-economic aspects, the data being processed from the classification of variables, or of sets of crossed variables.

Modelling necessary to identify any type of change, in this case, land use requires a local operation of mathematical maps.

The identification of hotspots (Table 5) is directly related to the major changes in the coastal zone throughout the period studied. These changes may be of a socio-economic and/or biophysical nature to locate these areas is fundamental in determining the classification thresholds for each variable in order to distinguish a particular point.

As for the biophysical aspects, all areas of change were identified as potential hotspots. At the socio-economic level, this analysis integrated variables as an absolute value of the resident population and the distribution of the population by sector of economic activity.

The analysis of the surroundings of hotspots (Table 5) implies the comparison of biophysical and socio-economic factors. As such, areas of land cover changes were first identified; then two buffers (1 km and 3 km) were created around these areas and the socio-economic features were identified in each new buffer polygon created; finally, these buffers were compared with the natural park limits. In this manner, hotspots, areas that suffered significant socio-economic transformations were related to the changes on the land cover.

The surroundings of hotspots were likewise seen from the opposite, i.e. first, socio-economic hotspots were identified; then the buffers around these hotspots were created; next, the biophysical characteristics of this neighbourhood were identified. Thus, it is possible to emphasise the areas of no biophysical change, and to try to understand the reasonsfor such stagnation.

Data Output

The visualisation and presentation of data taken on different forms, from the tables, to graphs, maps, and aerial photographs, allows the creation of several possibilities of graphic presentations of elements that are considered fundamental for analysis.

Capacities for the synthesis of visual information were explored in order to obtain the results desired, particularly by creating a set of thematic maps resulting from data crossing. The creation of various graphic and alphanumeric elements whit the GIS is one of the possible output proposed in this report.

This GIS methodology is based on the clear definition of the data to be included in each scale of analysis. A hierarchy structure of the organisation of information of diverse dimensions, must be at the base of the implementation of data bases for each regional level.

Finally, the development of empirical models that allow us to cross all information is one of the objectives of the methodology, that can only evolve insofar as it can integrate a more significant modelling component, sustained by spatial statistical techniques, aided by GIS functions of spatial analysis.

2.2.3. Land cover in 1975 and 1985

The land cover analysis of the coastal zone was based on the inventory of twenty-eight Level 3 classes and three Level 4 classes of the CORINE land cover (CLC) nomenclature. Information gathered in the field as well as from other studies of this region already completed by the research team (Lourenço *et al*, 1997) allow us to group these classes into twelve types of land cover. However, these groups do not entirely correspond to Level 2 of the CLC nomenclature. For instance, in the case of urban areas, urban fabric and artificial non-agricultural vegetated areas formed one group because the latter essentially correspond in that area to gardens and urban parks.

Moreover, class 3.2 of the CLC nomenclature (Shrub and / or herbaceous vegetation associations) was further divided into two distinct types: natural grassland areas such as moors and heathlands, and transitional woodland shrub areas. The reason for this distinction lies in the significant difference in land use of the areas. The existence of shrub areas can sometimes be an indicator of abandonment of agricultural land use, while natural grasslands in the Alentejo are often used as natural pastures, indicating an extensive use of the land.

Thus the classification of the land cover in twelve main groups, although it does not totally correspond to Level 2 of the CLC nomenclature, with the purpose of identifying the key land use changes in the coastal zone of the Alentejo. We have therefore adapted the CLC nomenclature to the specific ecological and social characteristics of Alentejo coast's.

In fact, this classification lead us to the conclusion that it is rather difficult to establish an automatic classification of land use changes based only on land cover changes. On the contrary, it is of prime importance to understand the specificity of the region where the study is conducted for the reason that one particular type of land cover may represent different types of land use.

For instance, shrub areas may represent the abandonment of agricultural use of the land, or on the other hand, as in the case of some areas in the Alentejo, an extensive use of the land. In fact, the *Montado*, which constitutes a system of extensive agro-forest-pastoral land use in the Alentejo, develops a shrub stratum during the fallow period. This shrub stratum protects the topsoil and allows for nutrients to be fixed in the soil and for the natural re-growth of cork oaks.

The Land cover in the Coastal Zone of the Alentejo

The land cover in this area is characterised by agricultural areas (45%) and by forest and semi-natural areas (52%). Other types of land cover are remnants, occupying less than 3% of the studied area (Fig. 20 and Table 6).

Table 6 – Land cover classes in the coastal area

LAND-COVER CLASSES	1975		1985	
	ha	%	ha	%
Artificial surfaces	1421	1,2	2129	1,8
Agricultural areas	53540	45,4	52638	44,6
Forests and semi-natural areas	61891	52,5	61839	52,4
Wetlands	665	0,6	665	0,6
Water bodies	456	0,4	789	0,7
TOTAL	117973	100	118059	100

Source: Lacoast, 1975; CORINE, 1985

A quantitative analysis of the land cover changes reveals a very low rate of change between 1975 and 1985[23]. However, it is possible to identify some significant land use dynamics associated to different processes of change, which will be discussed in the next chapter.

Although they are small ranges, the urban and industrial areas underwent some of the most significant changes between 1975 and 1985.

Artificial Surfaces

In the studied area, artificial surfaces correspond to the urban fabric and industrial areas. Besides the urban fabric (continuous and discontinuous), artificial non-agricultural vegetated areas (less than 1% of the total area) were considered as an element of urban areas. This results from the fact that these areas are gardens or urban parks within the urban centre of Sines or areas with a tourism function such as those near Tróia in the extreme north of the area studied (Tables 6 and 7).

Industrial and port areas constitute a class within artificial surfaces. In this region, they are closely related and it is impossible to understand the industrial dynamics of Sines without the extension of the harbour facilities. In the northern part of the coastal strip, the prison of Pinheiro da Cruz was likewise included in this category.

Urban and industrial areas reveal a significant increase in area. Although there was a minor increase (barely 76 ha) in urban areas (the continuous urban fabric of Sines), it is very important to note that this increase represents a growth rate of 41% in the period from 1975 to 1985. However, the important urban expansion visible nowadays near the coastline had not yet been detected in 1985.

On the other hand, the port and industrial areas (especially the latsone) registered a very important expansion (632 ha more). The port of Sines has four terminals (oil, petrochemical, multipurpose and general cargo), one fishing port and a marina. Designed in the late sixties, planned in the early seventies and operational since 1978, it is one of the few deepwater European ports enabling large vessels to dock. The extension of the harbour facilities (12 ha more) which occurred over the ten analysed years, were a very important growth factor of the industrial areas (a further 620 ha) and were responsible for the increase of population in the surrounding urban areas, especially in the new town of Santo André.

[23] The figures showing decreases or increases in area indicate the net differences obtained by subtracting the total areas of various types of land cover in 1985 from the data relating to 1975.

Table 7 – Land cover changes (1975-1985) in the coastal area

Land Cover			Area (ha) 1975	1985	CHANGE (1985 1975)	Growth rate %
1110	Urban Areas	Continuous urban	184	260	76	41
1120		Discontinuos urban	446	446	0	0
1410		Green urban areas	43	43	0	0
1420		Sport and Leisure facilities	155	155	0	0
1210	Industrial and harbour areas	Industrial or commercial units	550	1170	620	113
1230		Port areas	44	56	12	27
2110	Arable land	Non-irrigated land	30837	30009	-828	-3
2120		Permanently irrigated land	1807	1776	-30	-2
2130		Rice fields	2066	2066	0	0
2210	Permanent crops	Vineyards	397	397	0	0
2220		Fruit trees and berry plantations	129	129	0	0
2310	Pastures	Pastures	63	63	0	0
2410	Heterogenous agricultural areas	Annual crops associated with permanent crops	3424	3428	3	0
2420		Complex cultivation patterns	9181	8818	-363	-4
2430		Land princ. occup. agric. with significant area of nat. veg	3953	3964	11	0
2440		Agro-forestry areas	1683	1987	305	18
3110	Forest	Broad-leaved forest	12711	12565	-146	-1
3111		Cork oak	772	772	0	0
3112		Holm oak	56	56	0	0
3116		Eucalyptus	3719	3867	149	4
3120		Coniferous forest	14518	13872	-647	-4
3130		Mixed forest	18086	17994	-93	-1
3210	Natural grassland	Natural grassland	140	140	0	0
3220	Shrub	Moors and heathland	3127	2944	-183	-6
3240		Transitional woodland-shrub	3952	6858	2905	74
3310	Open spaces with little or no vegetation	Beaches, dunes, and sand plains	4809	2772	-2037	-42
4110	Wetlands	Inland marshes	22	22	0	0
4120		Peatbogs	94	94	0	0
4210		Salt-marshes	549	549	0	0
5210	Rivers, coastal lagoons and dam reservoirs	Coastal lagoons	27	27	0	0
5110		Water courses	209	209	0	0
5120		Water bodies	220	552	332	151
		TOTAL	117973	118059	86	0,1

Source: Lacoast, 1975; CORINE, 1985

Agricultural areas

Agricultural areas cover about 45% of the studied area and they are mostly located in the region south of Sines. These areas comprise arable lands that suffered a slight decrease (858 ha), permanent crops essentially composed by vineyards and orchards that were kepf in the area between 1975 and 1985 (526 ha), pastures which are a residual component (63 ha) without changes in area in use. Another category of land cover included in agricultural areas corresponds to heterogeneous agricultural areas that generally register a very small decrease (44 ha). In these areas, it is possible to note the association of different crops in the same field. In the Alentejo, and specifically here in its coastal strip, these areas are closely related with human settlements (urban or not) and they are intensively cultivated, giving the landscape a complex pattern where annual crops, pastures and permanent crops are juxtaposed (Tables 6 and 7).

Arable land

In the studied coastal strip,the arable lands are cultivated areas regularly ploughed and generally under a rotation system. The non-irrigated arable lands are (around 29% of the area and more than 85% of the arable land). These areas, made up of cereal cultivation, fodder crops and fallow land, reveal one of the most significant changes in land cover, a decrease of 828 ha between 1975 and 1985.

The other components of arable lands remain close to the same figures in the analysed period . Permanently irrigated land (nearly 1 800 ha) decreases of 30 ha and is confined to the bottom of some valleys. Furthermore, the area of rice fields (2 066 ha), which are particularly significant in the northern part of the coastal strip near the Sado estuary and in Melides lagoon, remains stationary.

Permanent crops

The surfaces occupied by vineyards and orchards are very small (526 ha, less than 0.5% of the area analysed). There are no changes between 1975 and 1985. Vineyards are mostly found in the north, near the penitentiary of Pinheiro da Cruz, where the prisoners labour some of the fields. Orchards are very insignificant and are located near the region of Sines.

Pastures

Although livestock production is very important in the Alentejo, very insignificant area is used for pastures (only 63 ha, nearly 0.1% of the area). This fact is certainly related to the nature of livestock production in this region,

where the extensive production of cattle, using natural pastures dominates. Moreover, the *montado* that corresponds to an agro-forestry land cover is surely included in these natural pastures.

Land cover, 1975-1985

Coastal zone - Alentejo

Fig. 20 - Source: CNIG, LACOAST,1975;CNIG, CORINE, 1985

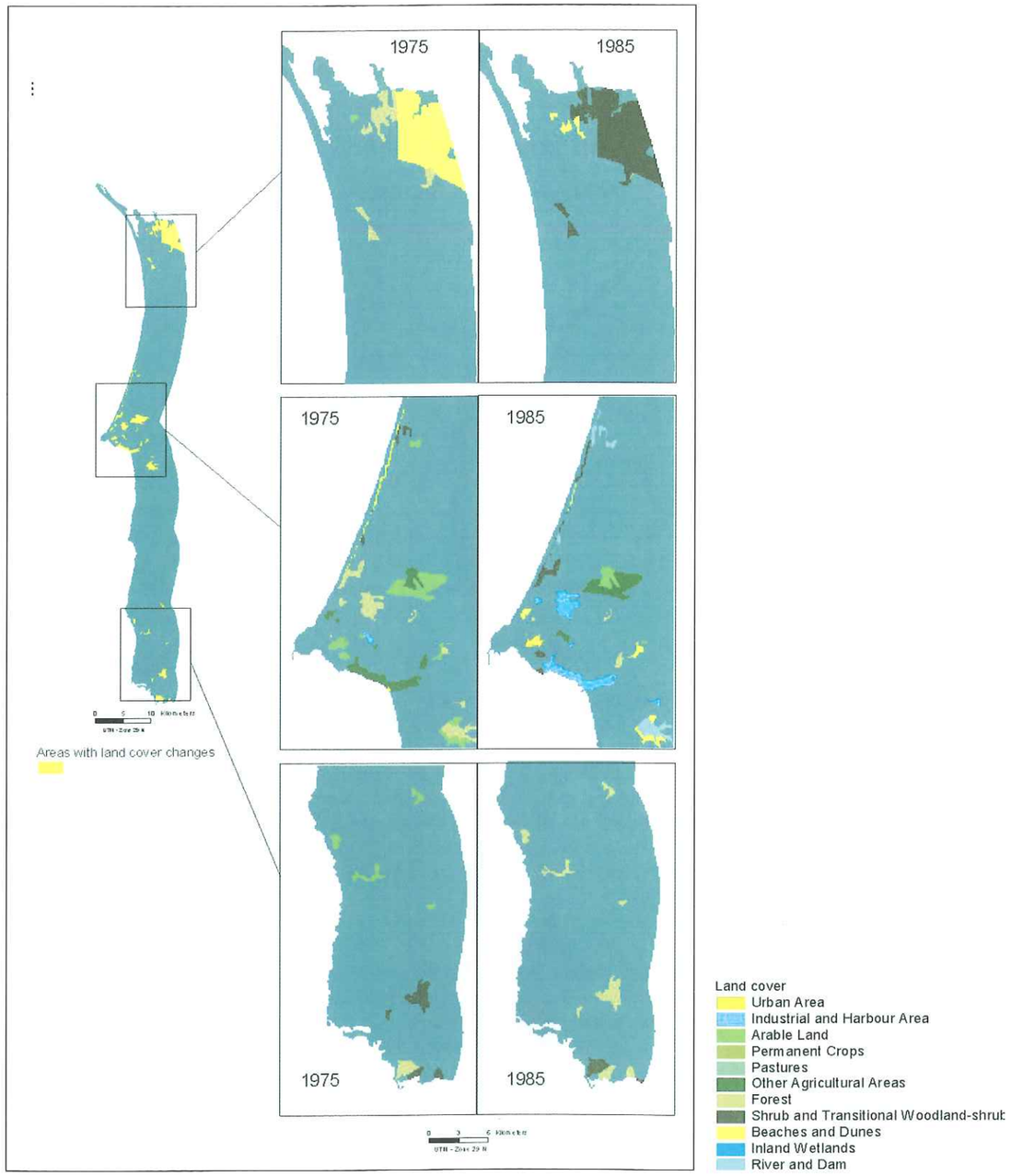


Fig. 20-a - Source: CNIG, LACOAT, 1975; CNIG, CORINE, 1985

Heterogeneous Agricultural Areas

As mentioned above, these areas have an association of various crops in the same field. They correspond to nearly 15% of the coastal strip and although a small negative net balance (-44 ha between 1975 and 1985), it is in these areas that some of the most significant land cover changes are evident.

In terms of changes, the most significant land cover classes within this category are the complex cultivation patterns and the agro-forestry areas that had an opposite performance during the studied period.

The complex cultivation patterns are in the areas the a juxtaposition of small parcels of diverse annual crops, pastures and/or permanent crops and they reveal a decrease in area (363 ha less). On the other hand, agro-forestry areas show a growth of 305 ha.

Although quantification of the changes shows similar figures, it doesn't mean the transfer from one to another. These changes are related to different processes of change that will be discussed later.

Forests and Semi-natural Areas

This category includes forestry areas, shrub and herbaceous vegetation associations and open spaces with little or no vegetation. The assemblage of these areas covers around 42% of the coastal strip, located mainly in the areas north of Sines.

Together with the agricultural areas, these classes of the CLC nomenclature comprise about 97% of the total area analysed (Tables 6 and 7).

Forest

The areas with forest covers almost 42% of the studied area. Although sometimes there is a dense land cover, mainly in the case of Pine trees and Eucalyptus, the density of the trees is generally medium to low, especially in the case of the *montado*[24] (Cork and Holm oaks). However, when the slopes are steep or when the soils are poor the *montado* can attain high densities (more than 50 trees per hectare).

The significance and diversity of species justify a more detailed analysis of this land cover category. Therefore, three main types of forest were considered: broad-leaved, coniferous and mixed. Moreover, some areas of Cork oak, Holm oak and Eucalyptus were also identified.

Broad-leaved

Areas covered by broad-leaved forest represent almost 11% of the total area and they decrease by 146 ha. This type of land cover basically refers to areas where Cork oak and Holm oak co-dominate, being very difficult to distinguish the two species due to the puzzling patterns of distribution. However, in the areas where it was possible to do so, three broad-leaved species were identified: Cork oak, Holm oak and Eucalyptus.

The areas where Cork and Holm oak separately predominate are very insignificant and comprise 812 ha (0.75% of the total area). These areas remained stationary between 1975 and 1985. On the contrary, the areas with Eucalyptus (nearly 3% of the coastal strip analysed) reveal a small increase (149 ha more).

Coniferous forest

The coniferous forest is mainly composed of maritime pine (*Pinus pinaster*) and stone pine (*Pinus pinea*). It is essentially located in the northern part of the coastal strip, covering the land with great density. Apart from this area, confined parcels near the coast to the south of Sines can also be observed. The group of the coniferous forest comprises approximately 13% of the coastal strip. It registered an important decrease (647 ha) between 1975 and 1985, occurring in the largest patch.

The use of these trees is mostly related to the production of wood, although resin and pine nuts were also produced.

Mixed Forest

Areas where broad-leaved and coniferous species co-dominate are more significant in the areas to the north of Sines. They cover about 15% of the coastal area and receded only 93 ha. This type of land cover is characterised by a puzzling association of Oaks, Pines and Eucalyptus revealing the expansion of some species of rapid growth, such as the Eucalyptus, in the forestry production cycle.

Natural grassland

Natural grassland areas are very insignificant, covering only 140 ha that remained unchanged between 1975-1985.

[24] The Oaks *montado*, although included in the CLC Nomenclature as a Forest, must be considered as woodland more than a forest.

Shrub

The areas covered with shrub vegetation are relatively important in the area. Its significance is more as indicator than the extension of the area covered, which is approximately 8% in 1985.

It is possible to identify two types of shrub areas: areas covered with moors and heath land, and transitional woodland shrub areas. Moors and heath land registered a decrease of 183 ha. These types of land cover are often used as an indicator of agricultural land abandonment . However, in these regions they represent an extensive land use system of *montado*. Nevertheless, given their location near the coastline, it is essentially characteristic of the natural vegetation of rocky or sandy coastal bands.

As the CORINE land cover technical guide indicates, the transitional woodland shrub areas are comprised of bushy or herbaceous vegetation with scattered trees, and can represent either woodland degradation or forest regeneration / colonisation. These areas show a significant increase of 2 905 ha representing 6% of the coastal strip studied in 1985.

To understand the underlying factors of that expansion is of paramount importance one of the most significant processes of change in coastal Alentejo. This issue will be discussed in the following section on the main dynamics of change in the coastal strip of the Alentejo.

Beaches, Dunes and Sand Plains

This land cover classe[25] represents the coastal sandy areas and, more important, the sand coverage of the existing bedrock especially in the northern border of the studied area. It reveals a very significant net decrease in area of 2 037 ha from 1975 to 1985. However, this significant decrease is closely related to the changes of land cover verified in only one field of the studied area. This field, situated near the northern border of the area, registered a decrease of 2 265 ha that is occupied in 1985 by the transitional woodland shrub vegetation (Tables 6 and 7).

This land cover change, identified also with the help of fieldwork, is related to the forestry production cycle which will be discussed in more detail in the section on the dynamics of change.

Wetlands and Water Bodies

The wetlands (inland and salt marshes and peatbogs) do not register changes in area (665 ha). They are situated at the edge of the Sado estuary, in the north of the area, and along the banks of the Mira river, situated to the south of Sines. The areas of coastal lagoons, rivers and water bodies include small coastal lagoons, especially the Santo André lagoon situated to the north of Sines near the town of Santo André, the Mira river and some dam reservoirs, the most significant of which is the one related to the Morgavel dam, which was not yet built in 1975. This constitutes the most expressive change related to these land cover classes (Tables 6 and 7).

Problems related to the filling up of coastal lagoons with sediments have arisen due to increasing human activity in the banks of these lagoons. This has given rise to the necessity of man-made aperture every year to the sea. Human activities in the banks of these lagoons include tree cutting that exposes the soil to erosion agents, providing a significant supply of sediment that fills the lagoons. Moreover, rice fields and the use of chemical products in the areas of irrigated cultures, contributes to the degradation of the environmental conditions of these lagoons, forcing a yearly artificial aperture.

2.2.4. The Socio-economic Dimension

The analysis below of the socio-economic dimension of land cover changes was based on the analysis of data from the 1981 and 1991 General Population Censuses. This data, provided by CNIG, is in the form of a grid, the result of converting data selected at the local level onto a kilometric grid.

In this section, we attempt to identify the most significant socio-economic changes registered between 1981 and 1991. All settlements (in the grid) located less than 15 km from the coastal line were considered. The area of study was therefore enlarged (5 km beyond the land cover data limit), since it was considered necessary to integrate the land cover changes to the socio-economic data on populations located next to the coastal fringe, even if they are found outside the 10-km buffer.

In addition, to allowing a significant approximation regarding the real population distribution, the level of data deseggregation used, facilitated the association of variables in view of creating socio-economic indicators of pressure on land use. Analysis of these values must be carried out with some caution, given that, oftentimes, the absolute values of each grid are very small, such that they might not be significant.

[25] Actually, it is rather improper to designate this category as a type of land cover. It is the substratum on which diverse land covers lay.

After identification of the main driving forces that are felt in the area of study, the most significant variables[26] in understanding urban, industrial, tourist, and agro-forestry dynamics shall be identified, as basis for the socio-economic analysis of the municipalities and parishes of *Coastal Alentejo*.

Analysis of Settlements / Grids

An initial phase of the analysis of the socio-economic dimension of urban dynamics constitutes an assessment of the changes that have led to the appearance or disappearance of kilometric grids (Fig. 21 and Annex 3) between 1981 and 1991.

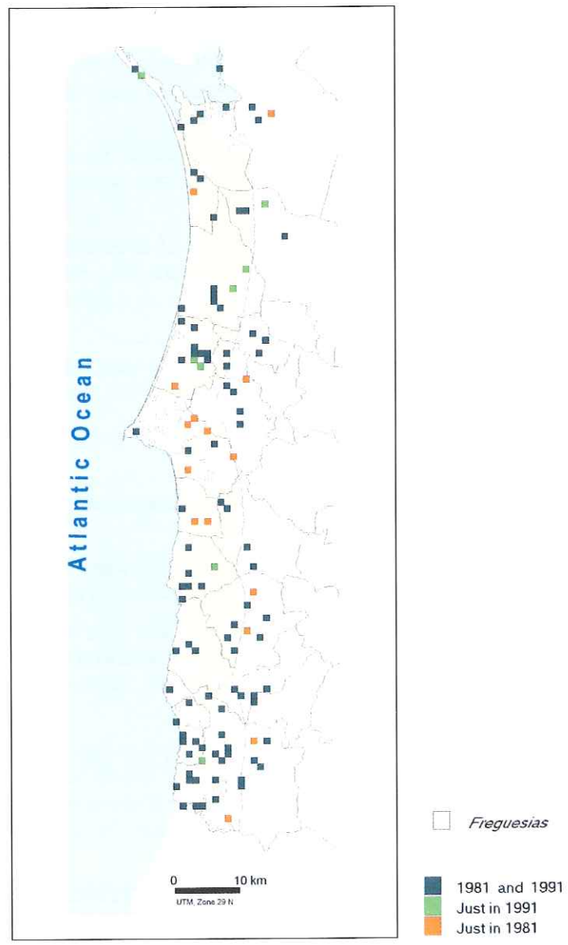


Fig. 21 - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981,1991

[26] Diverse socio-economic variables were analysed in this section. However, only those that appear to contribute more to the explanation of the main social dynamics are presented here.

Among these changes, the disappearance of fifteen grids is definitely associated with the disappearance of settlements throughout a process of localised depopulation[27].

On the other hand, the appearance of new settlements corresponding to eight grids is registered in 1991. In three cases, this must be related to the concentration of populations that had previously been residing in *montes*[28] situated in the environs of small population nuclei and which thus took on large-enough dimensions to be considered settlements. The increase in number of grids could likewise be explained by the population growth brought about by tourism-related activities, which seems to be the case in the areas of influence of Tróia, Zambujeira do Mar, and Vila Nova de Milfontes, or by the expansion in urban area, which seems to be the case registered in Santo André.

Resident Population

The evolution of the resident population allows us to add certain elements to the analysis of urban dynamics (Fig. 22), since it contributed to understanding population concentration in the main urban nuclei and the processes of depopulation of some areas.

The process of population concentration is especially visible in settlements next to the coastal line, which show high resident population growing rates. Despite the fact that this population growth results in part from the relocation of population to the interior of the 10-km buffer, it clearly reflects the movements of population originated from the most remote regions, the interior of the Alentejo, and other regions of the country, as was seen in the analysis at the regional level.

The areas that registered more significant population decreases are found in the north, next to the estuary of the river Sado, in some localities of the parishes of Grândola, Santa Cruz, and likewise in the southern sector of the coastal fringe of the parish of São Teotónio.

In the same figure, a sharp increase can be noted in the population of Sines and Santo André. The population increase of Santo André reflectis a growth in both the city of Santo André and a more spread-out development on the territory situated between this city and the urban centre of Santiago do Cacém, which nevertheless registers a significant decrease in its resident population.

In addition to this, there is population growth in Vila Nova de Milfontes, Alagoachos, Zambujeira do Mar, and Praia de Odeceixe, these being situated next to the coastal line. Next to the coast, there are few cases of settlements with a decrease in population, such as the case in Porto Côvo.

Present Population

The analysis of data relative to the present population[29] is important since it can provide information about the capacity of economic activities for attraction of labour to a given city.

The analysis of settlements in terms of present population shows that there are twelve where the present population is superior to the resident population by more than 100 individuals (Fig. 23).

Among the mentioned, cities the case of Pinheiro da Cruz must be noted since it registers a significant value in present population (711 more individuals present than residents, of which 90% are men) not related with economic activities. In fact, there is a prison establishment in this locality, which explains the high figure of the present population.

Analysis of the remaining settlements is interesting since it may reflect in this region the capacity of tourist activities to attract population of an indefinite kind, due to its seasonal nature. However, given that the date of the Census, 15 April 1991, corresponds to the low season of tourism, it seems to reinforce the hypothesis that the increase of the present population is related more to the attraction for labour than to the presence of touris ts.

Thus, the following areas are significant: Tróia, Lagoa de Santo André, Porto Côvo, and Zambujeira do Mar.

[27] It must be noted once again, that aside from the grids which, with a reduction in number of inhabitants were no longer considered settlements, a change in statistical criterion relative to the notion of settlement was observed, leading to the merging of some grids.

[28] In the Alentejo, the *monte*, is a group of farm buildings (housing and farm buildings). It could also signify a very small settlement of inhabitants scattered throughout the landscape.

[29] People who, at the time the census was carried out (at zero o'clock on 15 April 1991), were in a housing unit, regardless of whether they reside there, or who, while not being present, arrived there on or before 12 o'clock that day.

Resident population

1981/91

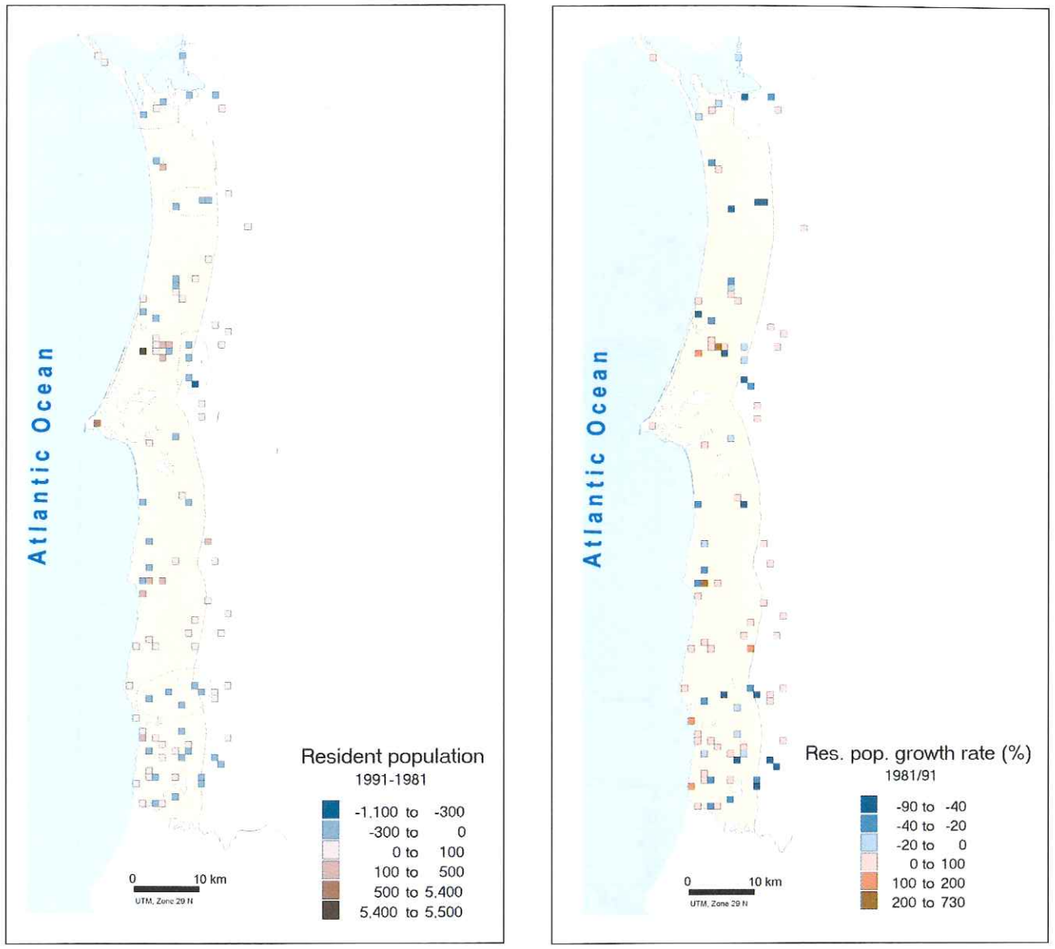


Fig. 22 - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981,1991

The Construction Dates of Buildings

The population growth in the area of Sines and Santo André was essentially considered during the seventies as a result of the development of the industrial area of Sines and the return of Portuguese nationals from the African ex-colonies.

However, the socio-economic data disaggregated by the kilometric grid is not available for 1970, and it is therefore not possible to show this growth at the level of the settlements. Nevertheless, it is possible to understand this growth from the variable that allows us to analyse the age of the buildings (Fig. 24).

Thus, nearly all buildings in Sines and Santo André were constructed between 1970 and 1985, resulting from the dynamics created by the strategic option to construct a new urban centre supporting the industrial area of Sines.

Present population
1991

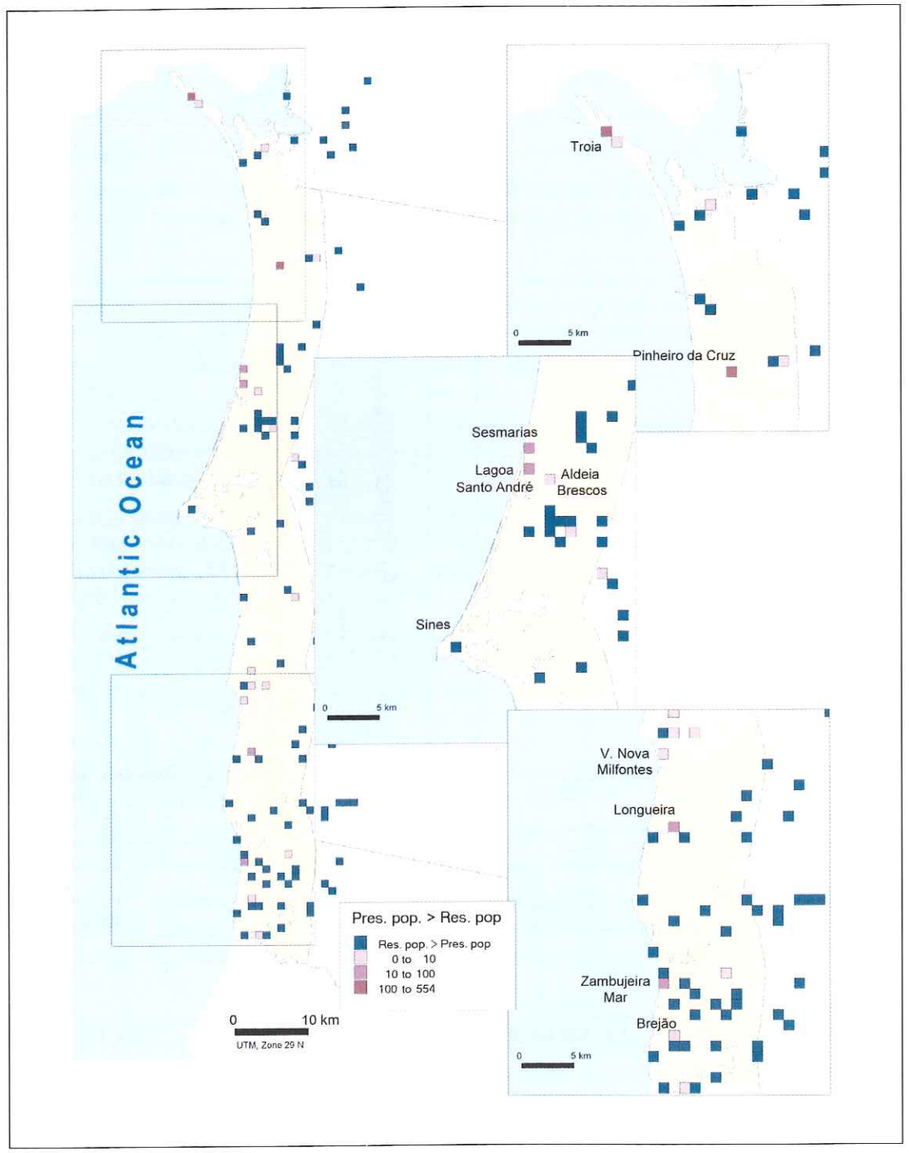


Fig. 23 - Source: INE, XII Recenseamento Geral da População,1991

The analysis of this variable allows us to observe that the settlements with buildings constructed mostly prior to 1970 are located in the interior of the 10 km-buffer. The ones with buildings constructed between 1970-1985 are mostly found, as mentioned above, in the area of Sines and Santo André, and likewise in localities next to the coastal line such as Tróia, Porto Côvo, Vila Nova de Milfontes, Almograve, and Zambujeira do Mar.

Buildings and construction date
1991

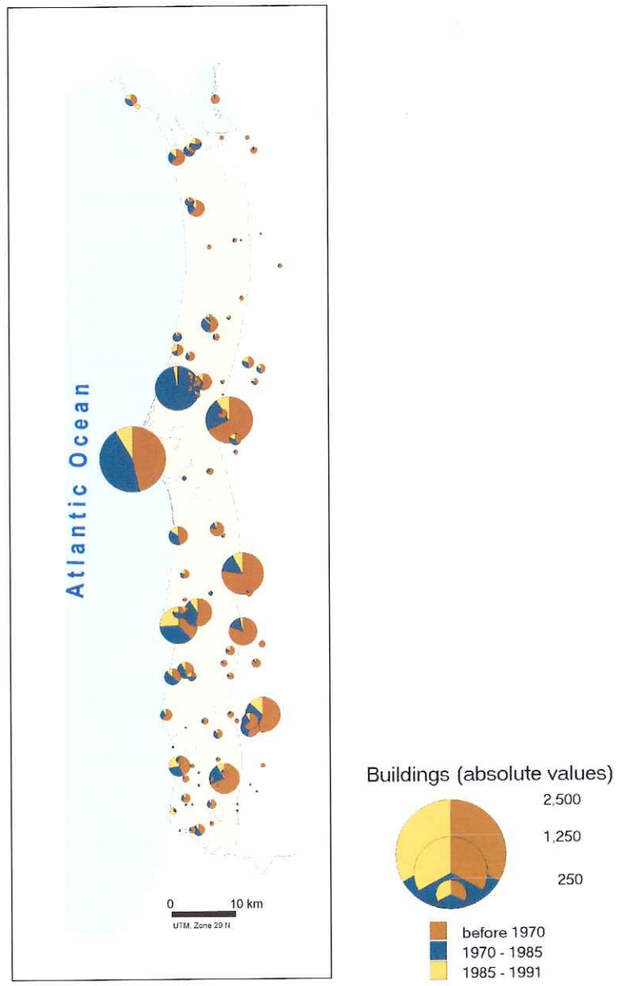


Fig. 24 - Source: INE, XII Recenseamento Geral da População,1991

The analysis of the settlements with a significant number of buildings constructed between 1985 and 1991 is of great importance, since it shows an urban growth that was not detected in the analysis of land cover dynamics, given that it occurred after the latest analysis date (1985). This variable registers significant figures in settlements such as Tróia (where there is a tourist venture entirely constructed after 1985), Lagoa de Santo André, Vila Nova de Milfontes, Zambujeira, and Azenha, where 25% of the buildings were constructed after 1985.

Secondary and Collective Households

Due to the impossibility to analysie hotels and other similar housing units[30]separately, it was only possible to analyse the distribution of secondary households[31]. This variable allows us to have an idea of the tourist dimension[32] to

which some settlements in the coastal zone of the Alentejo are subject, mainly in relation to holiday and weekend houses.

However, the analysis of the evolution of secondary and collective households between 1981 and 1991 shows a generalised increase. This movement is particularly relevant in some settlements located next to the coastal line and less significant in the larger urban centre of the coastal strip (Fig. 25).

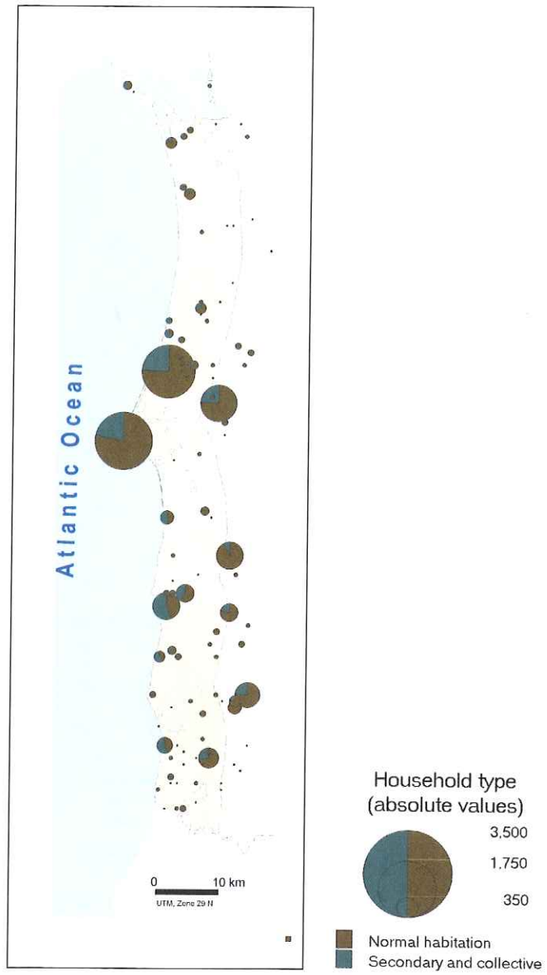


Fig. 25 - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981,1991

[30] This type of household is integrated into the category of collective households. These constitute houses which, due to the way in which they were built or remodelled, are intended to house more than one family and which, at the time of the census date, was occupied by one or more people, whether residents or non-resident present.

[31] This type of housing excludes classic housing (habitual residence) and includes housing classified as seasonal residence and those where the occupant was absent (immigrant, etc.).

[32] This variable is only available for 1991, being aggregated to collective households for 1981. Thus, it is impossible to obtain a growth rate for secondary households.

In 1991, the settlements where secondary households have a relative weight of over 50% show a strong coastal nature. In fact, of the eight settlements / grids (Table 8) with a larger number of secondary households than normal residences, only one (Vale de Coelheiros) is not situated next to the coastal line.

Table 8 – Households in 1991

Local Name	Total Households	Normal Habitation	Secondary Household	Collective and Vacant Household
V. Nova de Milfontes	1085	217	482	128
Zambujeira do Mar	502	92	264	21
Porto Covo	318	475	163	5
Almograve	222	150	102	28
Lagoa de Santo André	138	49	83	6
Sesmarias	93	19	72	2
Tróia	24	3	20	2
Vale de Coelheiros	10	2	4	3

Source: INE, Population Census 1991

Sectors of Economic Activity

The analysis of population distribution according to sector of activity in the dates analysed helps us to understand the growing importance of the tertiary sector and the reduction in importance of the primary sector.

In 1991, the activities of the primary sector[33] are still very important for the populations of settlements in the coastal of the Alentejo. Fishing, agriculture, and forestry in this area still employ a big part of the active population (Fig. 26-a). In 1991, there are only eight where the active population in the primary sector is less than 10%.

The analysis of settlements where more than 50% of the active population is in the primary sector shows a highly significant number, to be located mainly next to the estuary of the Sado, and in the southern sector of the coastal zone. It is very important to note that in many of these agglomerates, there was an increase of the active population in this sector of more than 50%.

However, this sector of activity lost significance in the majority of the settlements of the coastal zone between 1981 and 1991. Many of these settlements lost more than 20% of their agricultural population. This is certainly related with the general decrease in population and likewise with the movement to other sectors of economic activity[34].

The analysis of the distribution of the population in the secondary sector[35] reveals that these activities are predominant in only three cities (Fig. 26-b). Among these three, only one is next to the area of Sines. However, settlements with more than 25% of the active population in the secondary sector are in greater numbers. The area of Sines / Santo André and the sector south of the coastal zone clearly stand out.

In addition, these are the areas that show the highest growth rates of population involved in secondary activities – above 50 %. Analysis of these figures must however take into account the fact that in most of these places, absolute population figures are very low, so this type of growth has little impact on the population of the settlement as a whole.

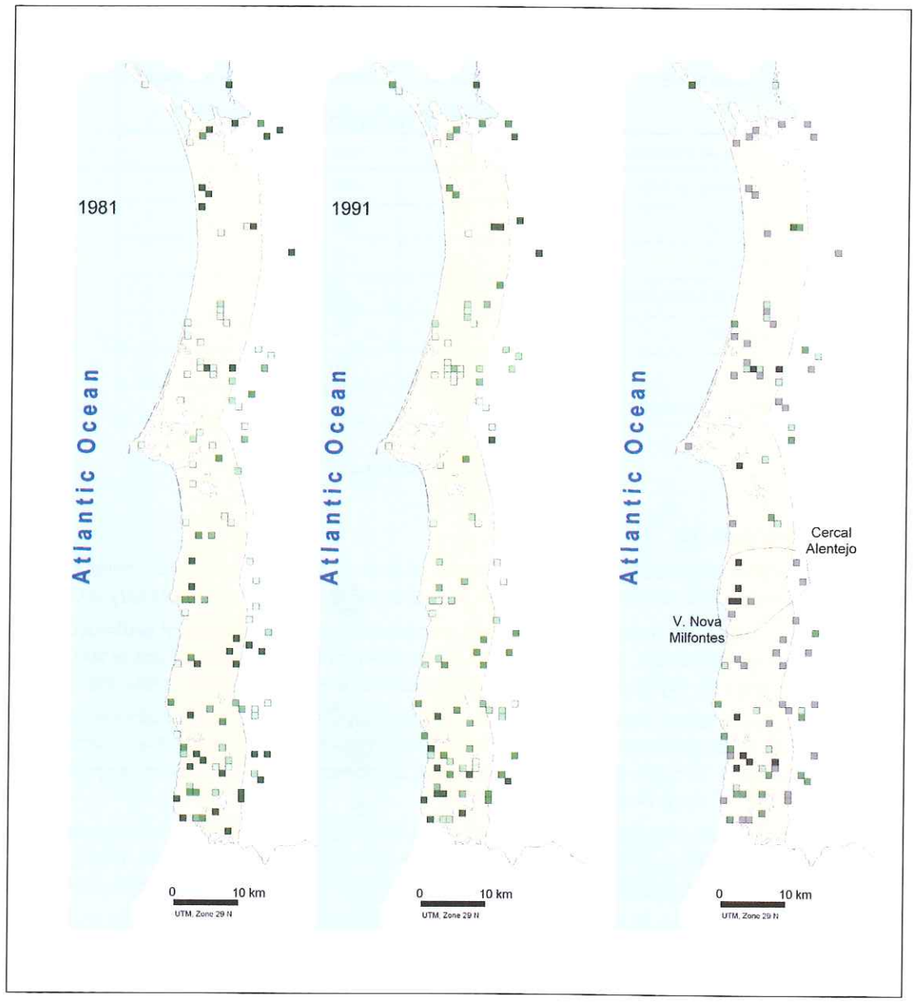
The largest growth of population employed in the secondary sector was registered during the seventies, or in other words, the data of the kilometric grid does not show this growth. On the other hand, the population employed in the secondary sector in the area of Santo André is associated with employment in the Industrial Complex of Sines, while in most of the cities located more to the south, this population is related to small industries and civil construction.

[33] Agriculture, livestock, silviculture, and fishing.

[34] In fact, the regional analysis between 1981 and 1991 shows a very important transfer of importance of the active population from the primary sector to the tertiary sector, the latter being of an essentially social nature and not support to the development of economic activities.

[35] Mining and manufacturing industries, construction and public works, production of gas and electricity.

Primary industry population
1981/91



Prim. pop./active pop
(%)

- 0 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 100

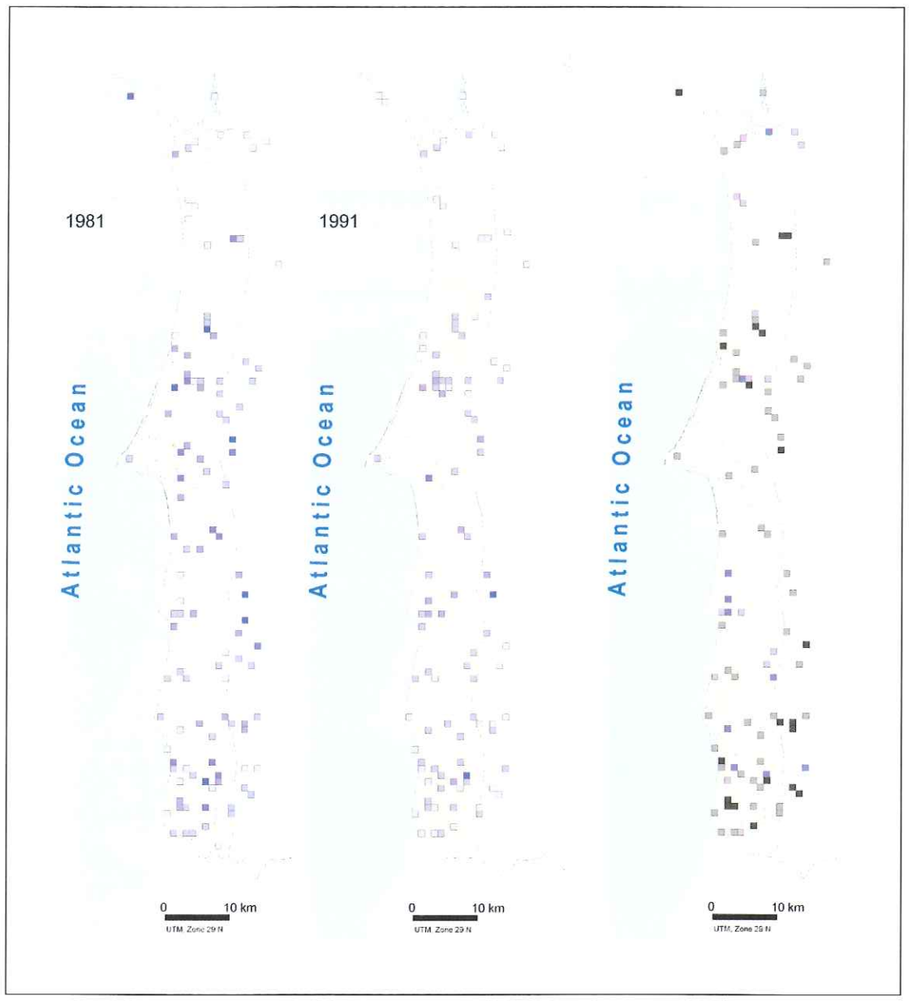
Prim. pop. growth rate
1981/91 - (%)

- -50 to -20
- -20 to 0
- 0 to 10
- 10 to 50
- 50 to 60

Fig. 26-a - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981, 1991

Analysis of the evolution of the tertiary sector[36] in this coastal zone is a good revealing of the type of socio-economic transformations that can be observed between 1981 and 1991 (Fig. 26-c).

Secondary industry population
1981/91



Sec. pop./active pop.
(%)

- 0 to 20
- 20 to 40
- 40 to 50
- 50 to 60
- 60 to 80

Sec. pop growth rate
1981/91 (%)

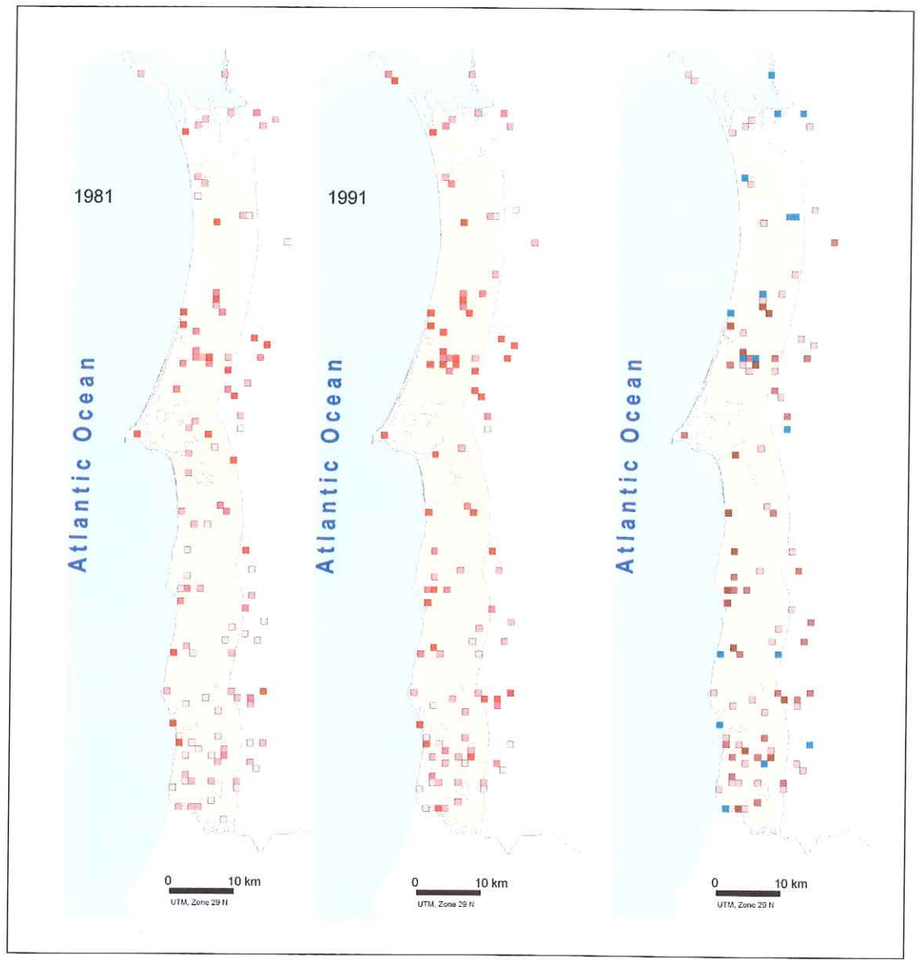
- -70 to -20
- -20 to 0
- 0 to 10
- 10 to 30

Fig. 26-b - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981, 1991

[36] Business, transports, and services.

Tertiary industry population

1981/91



Tertiary Pop.
(%)

- 70 to 100
- 40 to 70
- 30 to 40
- 10 to 30
- 0 to 10

Tert. pop./active pop. growth rate
1981/91 (%)

- -40 to 0
- 0 to 10
- 10 to 20
- 20 to 40

Fig. 26-c - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981, 1991

There was an increase, both in absolute and relative terms, of the population employed in the tertiary sector. This significant growth is shown as well in the increasing in number of cities where the activities of the tertiary sector are predominant, risen from ten settlements in 1981 to twenty-five in 1991. These cities are mostly found in the area of Sines / Santo André.

The biggest growth in active population (above 100%) was registered in the area of Santo André and agglomerations next to the coastal line such as Tróia, Alagoachos, Zambujeira, and Praia de Odeceixe.

Retired Population

Analysis of the retired population is interesting because it reveals the existence of settlements where this population is larger than the active populace. This variable has a heavier weight in the area of Santo André / Santiago do Cacém and still in the southern –most area, the municipality of Odemira (Fig. 27). This indicates the existence of a very old population. However, as it is known the social dynamics of the Alentejo region, this population is not entirely retired from active life, continuing to work essentially in agriculture. Hence, this may prove to be an interesting indicator in the analysis of agricultural and forestry dynamics[37].

Retired population

1981/91

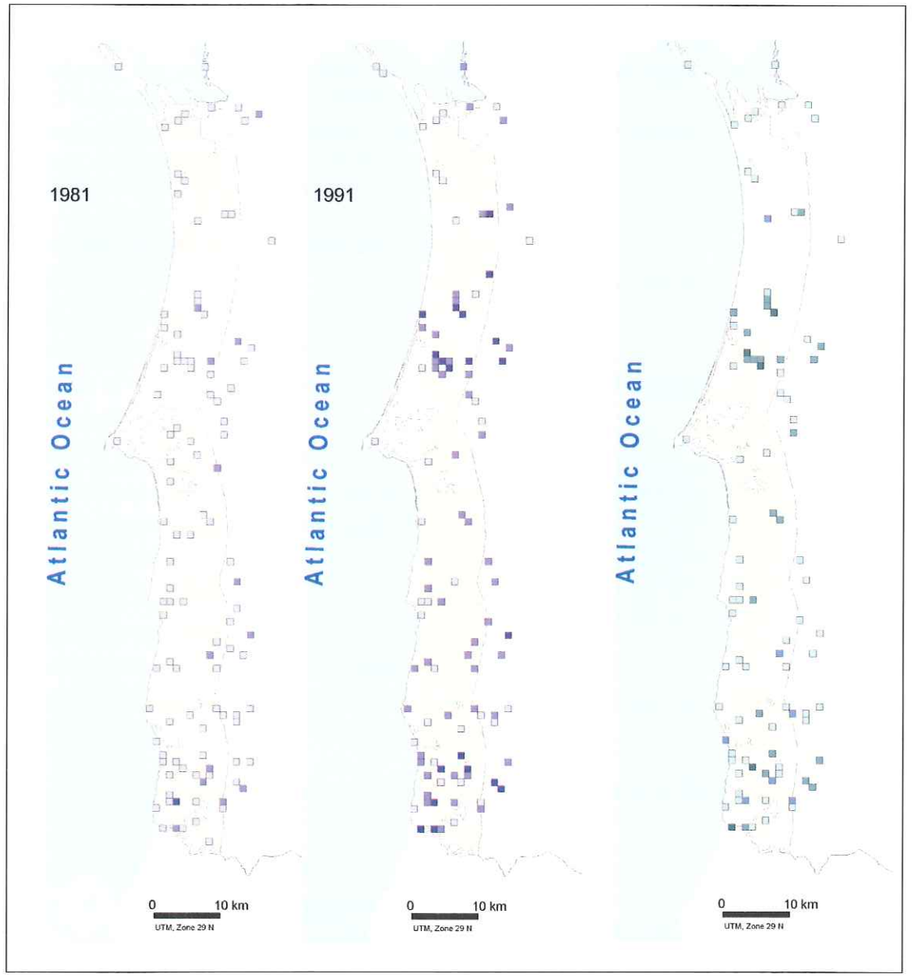


Fig. 27 - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981, 1991

[37] However, this hypothesis could only be confirmed with enquiries made with some of these individuals in order to discover their real intervention as agents of change in rural areas.

Land use Pressure Indicators

The set of variables analysed above helped to recognise for this coastal zone of the *Alentejo* four general types of socio-economic dynamics included in the main driving forces identified in the regional analysis.

Thus, it is possible to refer to the existence of an urban growth dynamics, explicit in the variation of the resident population, the active population in the tertiary sector, and the construction dates of the buildings. A dynamics of industrial growth associated mainly to the evolution of the active population in the secondary sector was observed as well. The dynamics of growth in tourist activities is related with the evolution of variables such as the active population in the tertiary sector, the distribution of secondary households, and the construction dates of buildings, being quite significant after 1985.

Lastly, an agricultural and forestry dynamics was identified, and this is associated with the evolution of the active population and the distribution of the retired population.

The cross-referencing of these various variables allowed us to construct indicators of socio-economic pressure on land use that will be developed in the following chapter.

3. LAND USE AND SOCIO-ECONOMIC DYNAMICS. PROCESSES OF CHANGE

The analyses of land use for the period between 1975 and 1985 based on the CORINE and the Lacoast databases show a low rate of change. This is certainly related to the weak socio-economic dynamism of the area. The study of many socio-economic indicators denotes that the Alentejo is one of the most peripheral regions of the country (Jorge, 1977 and Lourenço; Jorge; Machado, 1998).

In the areas of the Alentejo previously studied by the authors, there are generally no significant changes in the landscape (Lourenço *et al*, 1997). In recent years, the processes of change in land use have been characterised by the increase of the extensive use of available land, particularly the increase of the area of natural pastures, the conservation of the *montado*, and in tew cases the use, of areas, which had been previously used for cereal growing.

Extensification is a process often associated with the size of farms since as only a relatively large farm allows income levels to be sustainable. Apart from this, support measures for production and subsidies granted per hectare also contribute to the existence of extensive production systems in which farm management depends more on the kind of aid granted than market movement. CAP helps the extensification movement because, on the one hand, the aid granted under the guise of agro-environmental measures works as a complement to the farmers' income and, on the other hand, the attribution of grants per hectare contribute to the choice of extensive production and the reduction of costs related to production factors.

More than a global process, it occasionally results in the increase of production costs through more productive activities such as pig farming, vines, market gardening and the purchase of animals without acquiring land, increasing the production costs through fodder or leased pastures.

3.1. The Processes of Land use Change

It is already possible to mention some of the main factors of change present in the studied coastal area, which outlines this stage of the research:

- Geomorphologic evolution of the coastline
- Processes of intensification, extensification and abandonment of the agricultural production systems
- Influence of the industrial and harbour activities
- Growth of tourism and public administration employment

The consequences of these factors of change can be expressed by the following:

- Changes in agricultural and forestry uses of the land
- Urban concentration
- Expansion of industrial areas
- Growth of tourist areas
- Intricate patterns of urban and rural areas

It is therefore possible to identify some patterns of change in Coastal Alentejo (Table 9). These ones are particularly related to the expansion of the industrial harbour in Sines since 1978.

Table 9 – Processes of Change in the Coastal Band of the Alentejo

Processes of Change
Dynamics in Urban Areas
Non-irrigated arable land decreasing
Dynamics in Industrial Areas
Areas with complex cultivation patterns decreasing
Mixed forest areas decreasing
Dynamics in Agricultural Areas
Arable land decreasing
Areas with complex cultivation patterns decreasing
Agro-forestry areas increasing
Dynamics in Forestry Areas
Cycle of forestry production
Forestry areas increasing

3.1.1. Dynamics in Urban Areas

The dynamics in the urban areas of the coastal band of the Alentejo is characterised by a significant increase in areas of population agglomerations. However, for the period studied (1975-1985), this growth is visible only in Sines. In this urban centre, the continuous urban fabric registers an increase of 76 ha, and this growth was at the expense of non-irrigated arable land (Table 10 and Fig. 28).

Table 10 – Urban Dynamics

Land use in 1985	ha	Land use in 1975	ha
Continuous urban fabric	76	Non-irrigated arable land	76

Source: Lacoast, 1975; CORINE, 1985

Nevertheless, it can be noted that the growth of the urban fabric occurred after 1985, after the date of the CORINE Land cover. This growth is visible, with the help of other sources of information such as the 1995 aerial photographs, particularly the urban situated near the coastline. Among them, we can observe a highly significant growth in Porto Côvo and Alagoachos (expansion area of Vila Nova de Milfontes).

We can further note that Cidade Nova de Santo André (to the northeast of Sines) is an urban centre, which began to be built in the mid 70's. Meanwhile, the economic and social crisis of this period hindered the potential attraction of the area of Sines, rendering difficulties for the population of this urban centre for which it had been planned. As a result, in the beginning of the 90s, there were less than 10 000 habitants in Santo André.

3.1.2. Dynamics in Industrial Areas

In general, the surrounding area of the expanding urban centre of Sines seems to be the most dynamic. It is here where the land use changes are more significant. This results from the expansion of the industrial harbour, the construction of an electric power plant, and the installation of an oil refinery which was a significant focus of attraction for the population of the hinterland (Lourenço *et al*, 1998).

Therefore, in the recent years this industrial centre has been an important infrastructure responsible for the main land use changes observed in this region. These land use changes are expressed in the increase of the urban and industrial areas of Sines and in the enlargement of the harbour facilities. The extension of these areas (Table 11 and Fig. 29) results in the reduction of the more or less complex patterns of agricultural land use (360 ha), which is evident in the 1975 maps. Likewise, a significant decrease in the area of mixed forest (279 ha) was registered.

Table 11 – Industrial Dynamics

Land use in 1985	ha	Land use in 1975	ha
Industrial or commercial units	646	Complex cultivation patterns	360
		Mixed forest	279
		Beaches, dunes and sand-plains	7

Source: Lacoast, 1975; CORINE, 1985

Dynamics in urban areas

Land cover 1975/85

Fig. 28 - Source: CNIG, LACOAST, 1975; CNIG, CORINE, 1985

Dynamics in the industrial areas

Land cover 1975/85

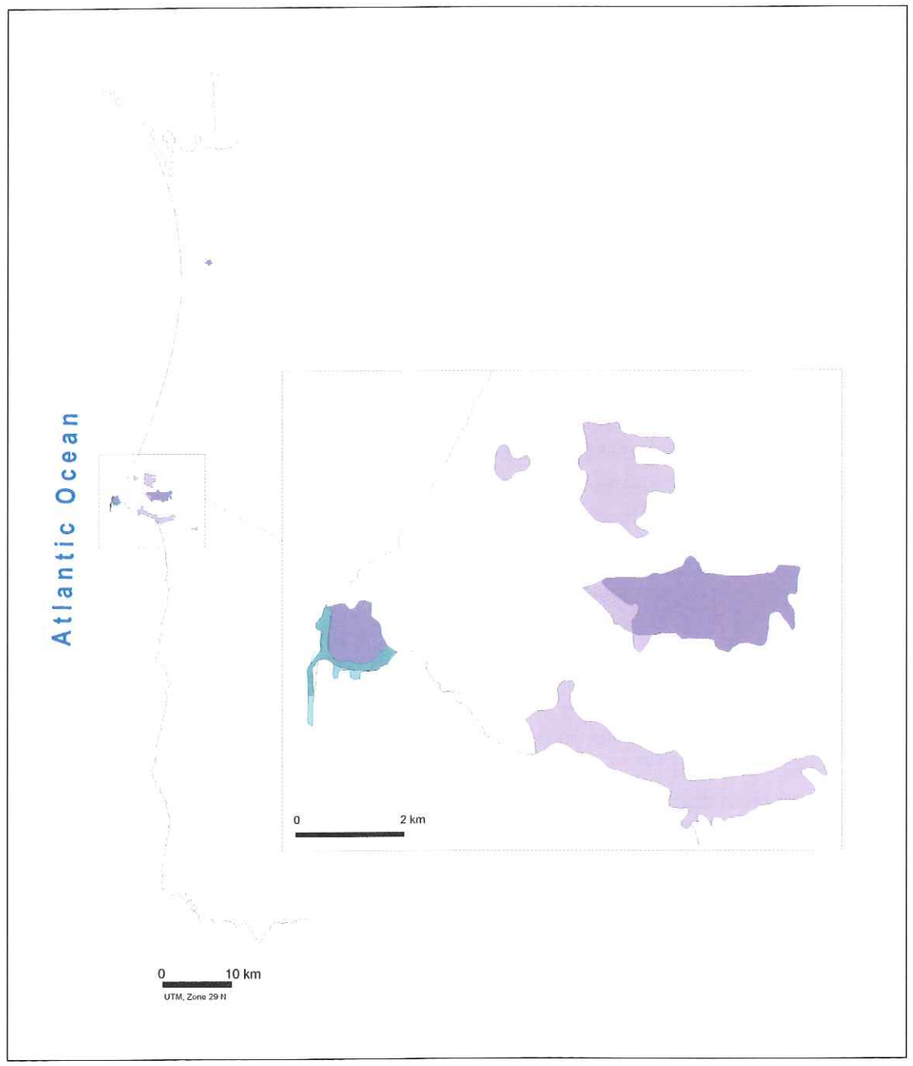


Fig. 29 - Source: CNIG, LACOAST, 1975; CNIG, CORINE, 1985

3.1.3. Dynamics in Agricultural Areas

The dynamics in the agricultural areas of the Alentejo coast is typified by a net reduction in the area of arable land (irrigated and non-irrigated) and complex cultivation patterns, as well as in the significant increase in agro-forestry areas (Tables 12 and 13).

The decrease in area of non-irrigated arable land seems to correspond to an important land use change, given that approximately 70% of the area were be used in 1985 for forestry or agro-forestry purposes.

On the other hand, it can be observed that the reduction in permanently irrigated land (30 ha) corresponds to the area that was occupied by the lagoon of the Morgavel dam. This dam was built essentially to supply the population of Sines with water, thus meeting the needs resulting from the increase of the population of this urban centre. The resulting lagoon is also responsible for the cover of around 155 ha of non-irrigated arable land that was grouped under the CLC classes Beaches, dunes and plains, due to the drop in water level in 1985.

As for areas with an agricultural use, a significant decrease in complex cultivation patterns is registered as well. In fact, it can be noted that 80% of these areas was used for industrial purposes in 1985. This land use change can be seen in the area of Sines in places where we find the thermoelectric power plant, the refinery, the industrial units related to petroleum derivatives, some sewer and residual water treatment stations, not to mention the new access roads to the Port of Sines.

Table 12 – Agricultural Dynamics. The decreasing of agricultural areas

Land-use in 1975	ha	Land-use in 1985	ha
Non-irrigated arable land	965	Agro-forestry areas	440
		Beaches, dunes and sand-plains	155
		Eucalyptus	151
		Continuous urban fabric	76
		Broad-leaved forest	70
		Moors and heath land	29
		Mixed forest	22
		Water bodies	15
		Complex cultivation patterns	7
Permanently irrigated land	30	Water bodies	30
Complex cultivation patterns	446	Industrial or commercial units	360
		Mixed forest	45
		Beaches, dunes and sand-plains	34
		Broad-leaved forest	7
Agro-forestry areas	134	Non-irrigated arable land	134

Source: Lacoast, 1975; CORINE, 1985

The dynamics in agricultural areas is likewise characterised by the significant increase in agro-forestry land. This rise (440 ha) occurred to the expenses of non-irrigated arable land, which has dropped. However, it seems necessary to take some precaution in analysing this specific change in land use. In fact, it refers only to one field situated to

the northeast of Sines (Figs. 20 and 20-a). The aerial photograph a from 1995 seems to show a land use type very similar to the remaining non-irrigated arable land and specifically to an adjacent field, showing a very low, almost inexistent, tree density.

It could be a change in criteria of the interpretation of the satellite image, or a process of change that is extremely rapid that it implies, in the space of sixteen years (1975-1991), the development of trees (which in this region are normally species of slow growth such as Holm oaks) and their cutting (with what aims?). It is a doubt that remains that can only be explained by contacting those responsible for exploiting the area.

Anyhow, there seems to be a significant decrease in arable land in the coastal zone of the Alentejo due to the conversion of this land to other uses, essentially for forestry but significantly more and more for agro-forestry use. On the other hand, the decrease in areas in which there is a more complex agricultural use (association of different types of cultures) is essentially related to the increase in industrial areas.

Table 13 – Agricultural Dynamics. The increasing of agricultural are

Land use in 1985	ha	Land use in 1975	ha
Non-irrigated arable land	140	Agro-forestry areas	134
		Broad-leaved forest	5
		Continuous urban fabric	1
Annual crops associated with permanent crops	2	Beaches, dunes and sand-plains	2
Complex cultivation patterns	42	Industrial or commercial units	35
		Non-irrigated arable land	7
Land principally occupied by agriculture...	13	Beaches, dunes and sand-plains	13
Agro-forestry areas	440	Non-irrigated arable land	440

Source: Lacoast, 1975; CORINE, 1985

3.1.4. Dynamics in Forestry Areas

The dynamics in forestry areas in the coastal strip of the Alentejo seem to be characterized by two processes; one corresponding to the actual increase in forestry area, and the other related to the land use change associated with the forestry production cycle (Table 14).

For this type of land use the information obtained by satellite is not enough. In fact, it is very difficult to immediately say if the changes registered correspond to an actual land use change or not. Thus, we can only suggest some hypotheses based on our knowledge of the region, obtained from previous studies and a field survey.

Only around 40% of the areas that registered in 1985 a change to forestry cover seem to indicate an actual increase in the forestry area. This process of increase in forestry area corresponds to the use of non-irrigated arable land (243 ha) and complex cultivation patterns (52 ha) for forestry production, mainly Eucalyptus, broad-leaved and mixed forest.

Table 14 – Forestry Dynamics

Land use in 1985	ha	Land use in 1975	ha
Eucalyptus	310	Non-irrigated arable land	151
		Others	159
Mixed forest	355	Complex cultivation patterns	45
		Non-irrigated arable land	22
		Others	288
Broad-leaved forest	77	Non-irrigated arable land	70
		Complex cultivation patterns	7

Source: Lacoast, 1975; CORINE, 1985

However, this increase in forestry is very slight, corresponding to approximately 0.7% of the forestry area in 1985.

As mentioned above, other changes in the area that may be observed seem to point more to a cycle of forestry production than an actual increase in area of forestry in the coastal strip of the Alentejo.

Thus, various changes in land use affect both different types of forest, such as the increase in area of Eucalyptus and Mixed forest, and other types of land use, such as Beaches, dunes and sand-plains, Moors and heath land, and transitional woodland shrub. This type of change seems to follow a distinct forestry production cycle that begins with the clearing of cultures in a particular parcel. This leads to a parcel where the rocky substratum (in the area, essentially sand) crops out to the surface. Then, trees are planted and a shrubby layer, sometimes very dense, naturally develops. This contributes to the protection of young trees and the fixation of nutrients in the soil. In a third phase, the trees grow and give rise to a productive forest until they are cut, beginning the cycle once again (Fig. 30).

This cycle represents the following land uses: a phase corresponding to the clearing of the land is illustrated by the parcels where beaches, dunes and sand plains are observed. Naturally, in these areas, the sand plains are particularly subject to this item of the CORINE legend, given that the other classes (beaches and dunes) correspond to more specific and easily recognised conditions.

A phase corresponding to the incipient development of trees together with a shrubby layer can be associated to moors and heath land (when the undergrowth is very dense rendering difficult the identification of trees). It can also be associated to a transitional woodland shrub that corresponds to a category of land use indicating a phase of transition between the undergrowth and forest representative of a phase of tree growth a little more advanced (or a degradation of the forest itself).

The phase of full growth of the trees corresponds to different forest categories identified in the area and it consists mainly of pines, eucalyptus, cork oak and Holm oak, in pure or associated populations.

The analysis of Table 15 reveals an increase (317 ha) in area of beaches, dunes and sand-plains. This increase seems to result from the preparation of land for forestation, such as the case of areas that consisted in 1975 of agricultural land (Non-irrigated arable land (155 ha) and Complex cultivation patterns (34 ha)). Aside from this, these areas developed over others that were occupied by forest (127 ha) in 1975, thus showing a posterior phase to tree felling.

Moors, heath land, and the transitional woodland shrub correspond to two categories that, as mentioned above, can reveal a phase of transition to developed forest. This type of land use develops in areas that in 1975 were non-irrigated arable land (possibly corresponding to an enlargement of the forest area by 29 ha) or forest that was cut down (823 ha). In this case, the 1985 image already registered a phase of evolution in the forest production cycle posterior to the preparation of land with the cutting of trees and undergrowth, having had time for the development of shrubby vegetation.

Nevertheless, it is in this category of land use that one of the more significant changes can be noted. This change is not only important by the extension of the area affected (2 296 ha), but also by the fact that it is found concentrated in only one field situated next to the extreme north of the area in study. The land use change registered here

is well representative of the cycle of forest production that has been referred to. Thus, in areas where the coniferous forest is extremely important, some areas, are almost totally dominated by forestry, the regular cut of pine trees being evident for the wood industry.

Table 15 – Forestry Dynamics

Land use in 1985	ha	Land use in 1975	ha
Beaches, dunes and sand-plains	317	Non-irrigated arable land	155
		Complex cultivation patterns	34
		Coniferous forest	108
		Broad-leaved forest	19
		Transitional woodland shrub	1
Moors and heathland	29	Non-irrigated arable land	29
Transitional woodland shrub	3119	Beaches, dunes and sand-plains	2296
		Coniferous forest	529
		Eucalyptus	174
		Mixed forest	120
Eucalyptus	310	Non-irrigated arable land	151
		Transitional woodland shrub	143
		Mixed forest	11
		Coniferous forest	5
Mixed forest	355	Beaches, dunes and sand-plains	23
		Moors and heathland	233
		Transitional woodland shrub	24
		Complex cultivation patterns	45
		Non-irrigated arable land	22
		Eucalyptus	8

Source: Lacoast, 1975; CORINE, 1985

As for the increase in forest area, there seems to be a trend in the increase of the area of eucalyptus, mainly in the southern most sector of the studied area. Here, forest area covers approximately 150 ha, where in 1975, it was non-irrigated arable land. On the other hand, it is not possible to ascertain that the huge decrease in the area of pine trees (529 ha) that is registered in the north corresponds to an actual reduction in forest area. Given that a woodland shrub cover is observed to be transitional, it seems to integrate the cycle of forestry production.

Tosumbalise the analysis of the dynamics of land use change in the coastal zone of the Alentejo shows that the changes are quite small and are significantly concentrated in the area around Sines. This fact reveals a peripheral position, in socio-economic or geographical terms. The industrial area of Sines has the greatest dynamism. With regard to land use change, its impact is mainly felt in the installation of industrial units on land previously used for agricultural purposes.

On the other hand, forestry changes seem to be less evident that those suggested by the analysis of the 1975 and 1985 satellite. In fact, all the transformations seem to be part of a distinct cycle of change, the cycle of forestry production, and not an actual expansion or reduction of forest area.

Moreover, the most significant land use changes, which can be perceived in the landscape today, were the result of actions taken over the last decade, after 1985, more recent than the date of CORINE. Therefore, due to the difficulty in introducing these more recent changes in the context of the analysis carried out, it is of prime importance to bring up to date the relevant information on Land cover and Land use. Nevertheless, it can be

Dynamics in forestry areas

Land cover 1975/85

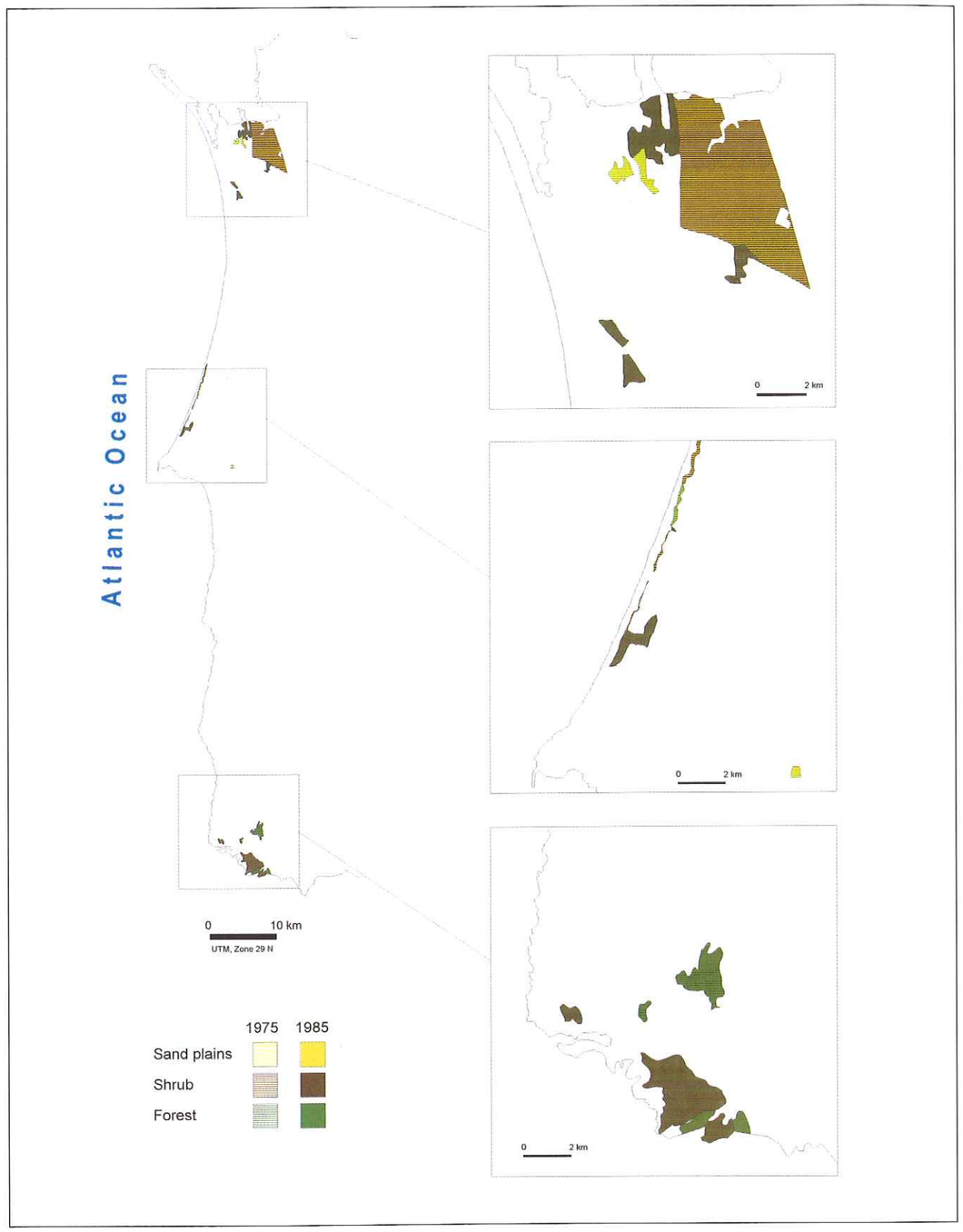


Fig. 30 - Source: CNIG, LACOAST, 1975; CNIG, CORINE, 1985

observed that these land use changes are significantly localised. They concern mainly the growth of small population centres located near the coastline and are related to the increase of tourist attraction. This growth can also be seen in the construction dates of buildings.

These changes will have impacts on the landscape and can negatively affect both the quality of environmental resources, such as soils and water, and the sustainability of food production. Therefore, this methodological approach can be an important tool in answering and supporting the need for proper territorial planning and landscape preservation.

Following the identification of land use changes, the next stage comprises the association of socio-economic data with those changes. This analysis will determine which socio-economic data can be closely related to the changes in land use. At the same time, they should be of use to the integrated methodology and help us to understand at different levels of analysis, the causes and meaning behind processes of land use changes.

3.2 Socio-Economic Pressures on Land Use

Four indicators of pressure on land use were formed based on the analysis of socio-economic variables. This was possible for the coastal zone of the Alentejo due to the existence of data disaggregated at the level of the settlement and available in the form of a kilometric grid.

Triangulated Irregular Network (TIN) data models were created as a cartographic representation of tourist, urban, industrial, and agro-forestry pressure indicators. This model is based on the possibility of attributing a third dimension to the various phenomena. It consists in the interpolation of data relative to the points (settlements / grids) in order to create a set of areas determined by their triangular form. The main aim of this process is to obtain a constant plane from a phenomenon that has a punctual (discrete) expression. This triangulation is based on principles of the topological structuring of relating objects (points – settlements). The algorithm used to carry out this TIN had the main effect of easing the slopes in steep elevations.

From these TIN models, it was possible to represent summary indicators on a constant plane, which allowed for the association with data on land cover changes.

The above-mentioned data modelling made way for the formation of the following indicators: Urban Pressure, Industrial Pressure, Tourist Pressure, and Agro-Forestry Pressure. The variables selected in these indicators are weighted equally, so that the number of variables present in each settlement evaluates socio-economic pressure. Thus, the more variables present in a given settlement, the greater the pressure will be.

3.2.1. Urban Pressure

Five variables were used to form this indicator:

- Active population in the tertiary sector in 1991, equal to or more than 50 %;
- Growth rate of the active population in the tertiary sector between 1981 and 1991, equal to or more than 100%;
- Active population in the primary sector in 1991, less than 10%;
- Settlements with more than 100 inhabitants and with more than 50 % of its buildings constructed after 1970.

The cross-referencing of these five variables using the Geographical Information System developed for this study resulted in the Urban Pressure Indicator (Fig. 31).

The analysis of this map shows the heavy urban pressure that is felt in the area located between Sines and Santo André. To this area, where the five selected variables are present, the following areas can be added: Tróia, Vila Nova de Milfontes (and mainly settlements that are developing in the surroundings of this urban centre, such as Alagoachos), Zambujeira do Mar, and Azenha .

3.2.2. Industrial Pressure

The following variables were used for this indicator:

- Active population in the secondary sector in 1991, equal to or more than 30%;
- Growth rate of the active population in the secondary sector between 1981 and 1991, equal to or more than 100%;
- Settlements with more than fifty inhabitants.

This indicator (Fig. 32) shows that the areas under the greatest industrial pressure are, once again, located between Sines and Santo André, and likewise the locality of Alagoachos, located in the environs of Vila Nova de Milfontes.

In addition to this, in a vast area of the coastal band the localities show two of the variables selected to form the Industrial Pressure Indicator. This fact is certainly related to both the small industries and activities related to civil construction.

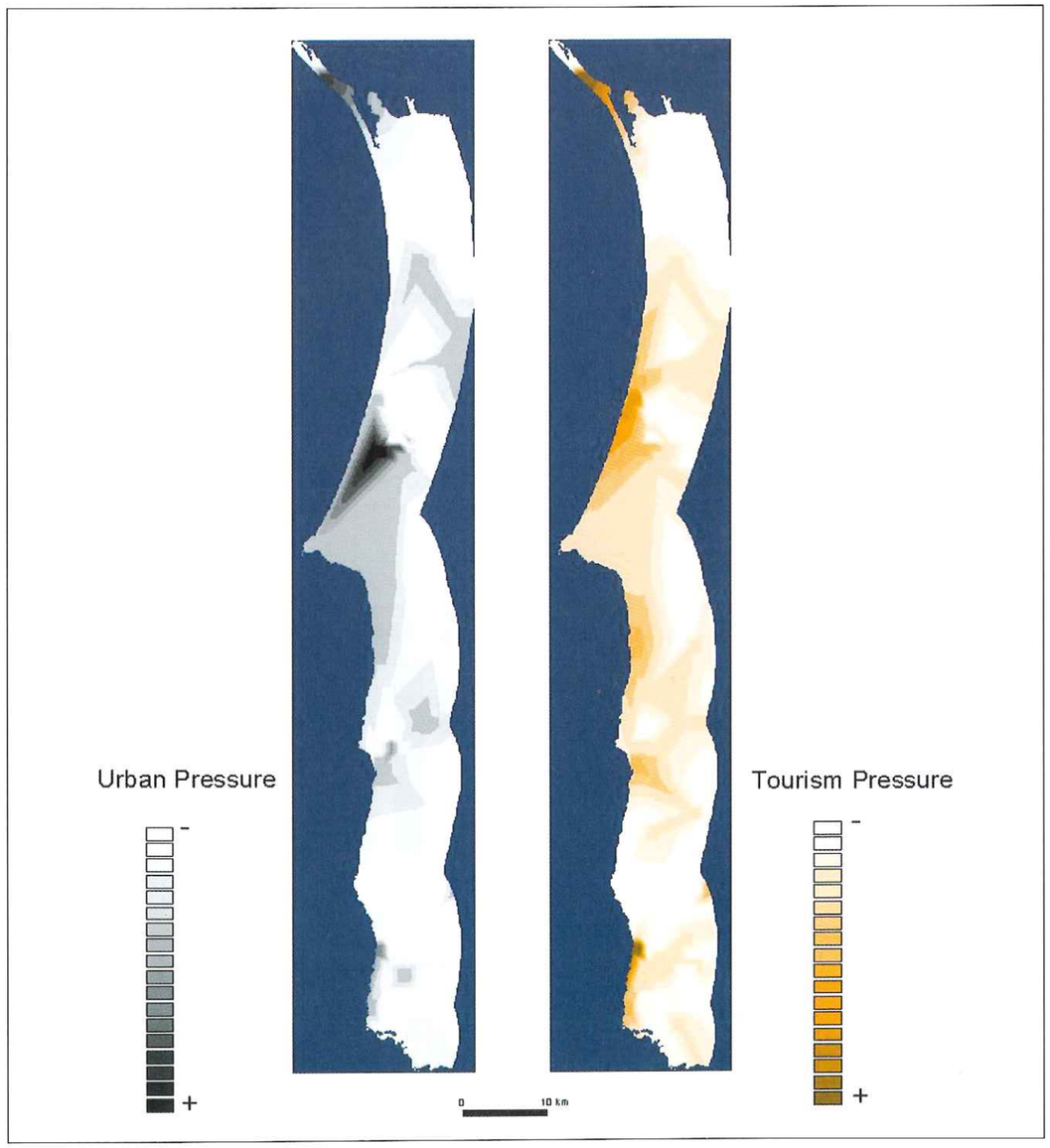


Fig. 31 - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981, 1991

Industrial pressure
1981/91

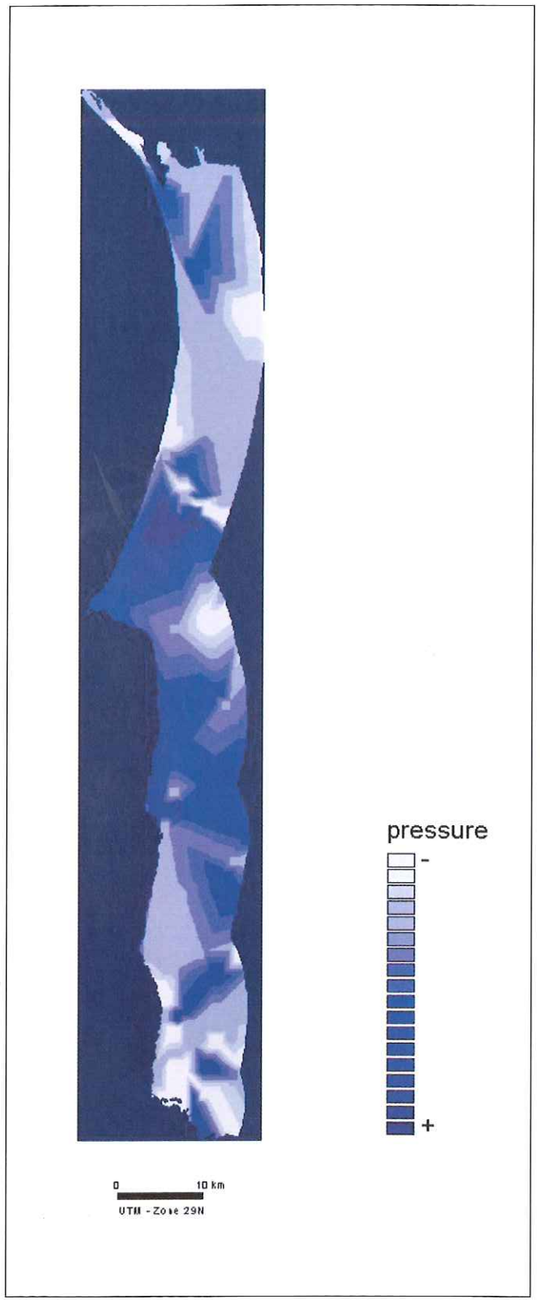


Fig. 32 - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981, 1991

3.2.3. Tourist Pressure

Four variables were cross-referenced to form this indicator:

- Active population in the tertiary sector in 1991, equal to or more than 50%;
- Growth rate of the active population in the tertiary sector between 1981 and 1991, equal to or more than 100%;
- Settlements where the number of secondary households is superior to the number of normal habitations;
- Settlements with more than 100 inhabitants and with more than 20% of its buildings constructed between 1985 and 1991.

It was not possible to integrate a variable related with the number of hotels into the Tourist Pressure Indicator, given that this data is aggregated with collective buildings[38]. As such, the indicator essentially reflects one of the dimensions of tourist pressure, resulting from secondary and weekend households.

However, the map (Fig. 31) is very clear regarding the pressure existing mainly in settlements next to the coastal line. Thus, higher valves of tourist pressure are located in: Tróia, the area adjacent to Lagoa de Santo André, Porto Côvo, Vila Nova de Milfontes, and the coast located between Zambujeira do Mar and Praia de Odeceixe.

It is interesting to note the differences between Vila Nova de Milfontes and the urban development in its surroundings when this indicator is compared with urban and industrial pressure indicators. While Vila Nova de Milfontes reveals significant tourist pressure, Alagoachos is subject to greater industrial pressure.

3.2.4. Agro-forestry Pressure

This indicator was based on the cross-referencing of three variables:

- Active population in the primary sector in 1991, equal to or more than 50%;
- Growth rate of the active population in the primary sector between 1981 and 1991, equal to or more than 50%;
- Settlements where the retired population is more than the active population.

The cartographic representation of the Agro-Forestry Pressure Indicator (Fig. 33) clearly shows the contrast with the indicators above. The areas with the greatest pressure are found far from the coastal line. The following areas are exceptions to this general distribution: Praia de Odeceixe and Zambujeira do Mar. Here, fishing activities must certainly take a more considerable weight in the context of the activities in the primary sector.

3.2.5. Global Pressure

The analysis of these four indicators of socio-economic pressure on land use shows that there is a sharp contrast between the combined pressure from urban, industrial, and tourist dynamics on the one hand, and agro-forestry pressure on the other (Fig. 34).

While the combined pressure of urban, industrial and tourist growth is felt mainly next to the coastal line, the agro-forestry pressure is more evident in the in land of the Alentejo coastal strip.

Among the places subject to a greater pressure from socio-economic dynamics related to land use change are the following: Tróia, located in the extreme north of the coastal strip; the area next to the coastal line between Santo André lagoon and Vila Nova de Milfontes; and the coast between Zambujeira do Mar e a Praia de Odeceixe. These places are greatly affected by the growth of tourist activities in this coastal zone.

Adding to these, the vast area located between Sines and Santo André shows an urban growth related to the development of the Industrial Complex of Sines.

3.3 Understanding the factors affecting change: integration of socio-economic and nature dimensions

In this section, we try to understand how land cover dynamics are related to the socio-economic dynamics identified in the coastal zone of the Alentejo.

[38] A set of premises intended for a large group of people subject to an authority or a common administration, linked by a common objective or common personal interests. Social welfare, educational, health, religious, military, prisonal, and work institutions, are included in this group.

Agro-forestry pressure
1981/91

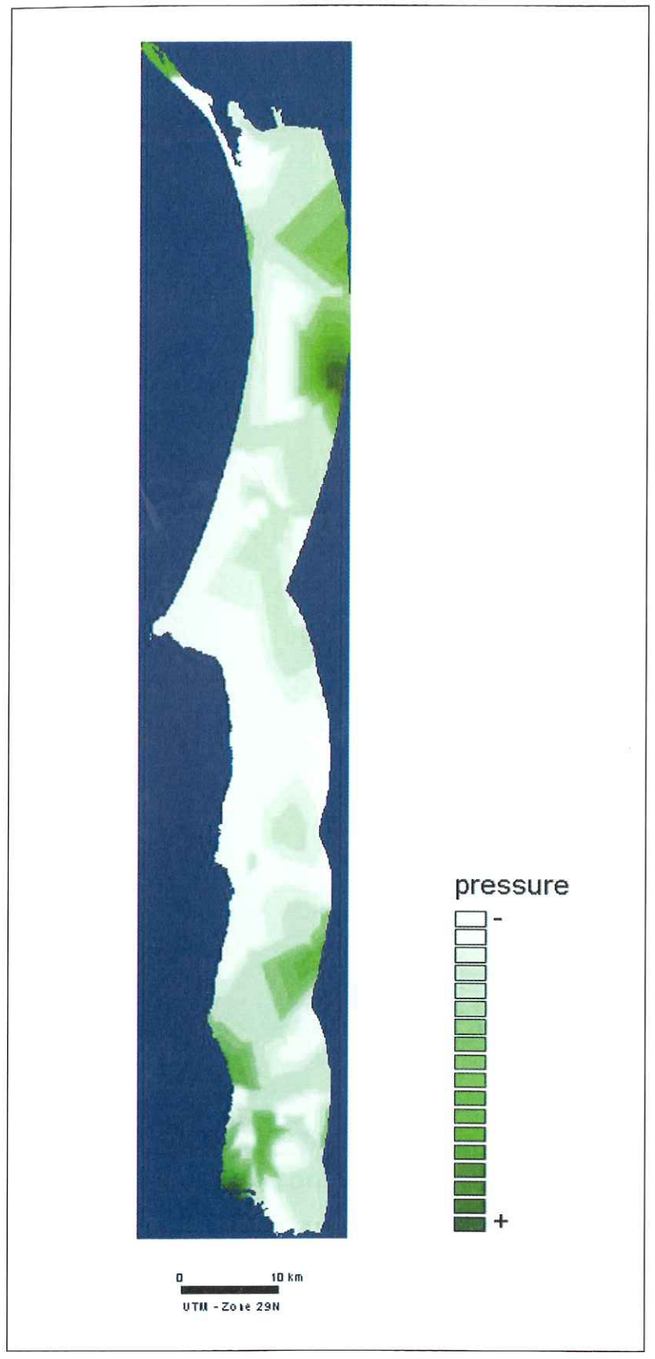


Fig. 33 - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981, 1991

Urban, tourism and industrial combined pressure
1981/91

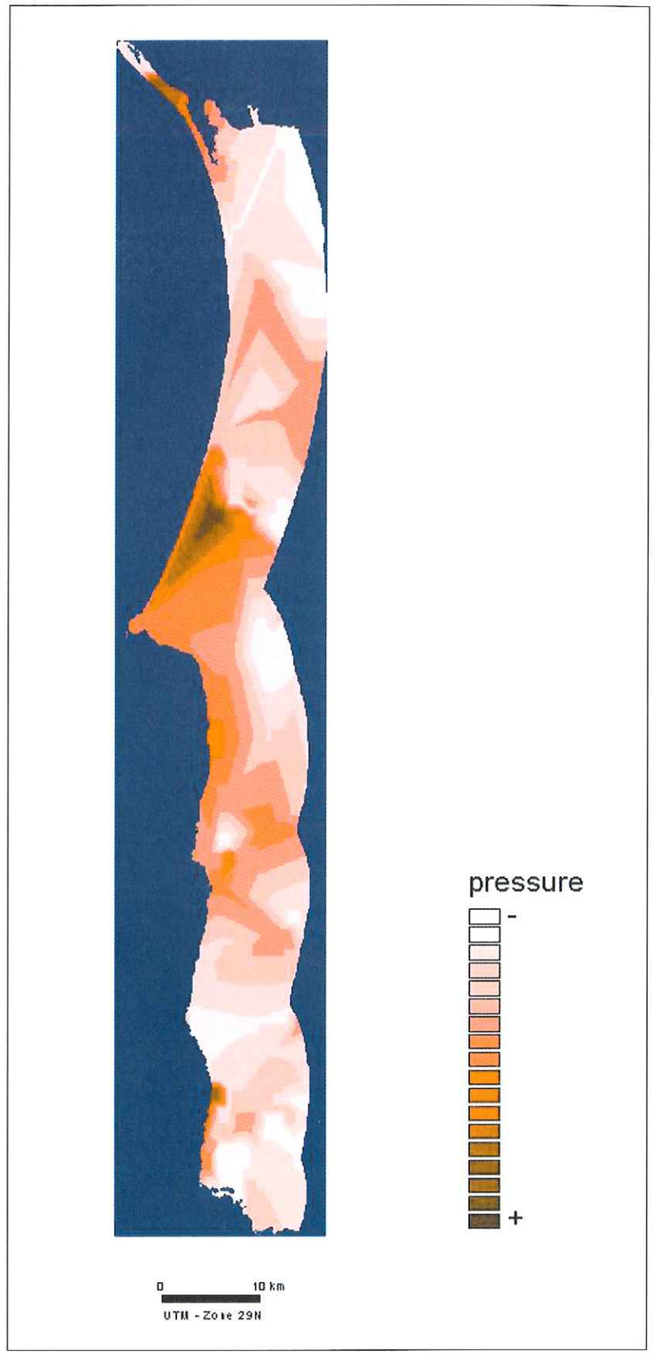


Fig. 34 - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981, 1991

As it mentioned before, it is not easy, if at all possible, to find cause and effect relations between land cover changes and socio-economic dynamics[39]. Therefore, we sought to understand how these two types of dynamics are related.

The land cover of this coastal zone is mainly characterised by its agricultural and forestry nature, not having suffered great changes in terms of expansion or reduction of this type of land use between 1975 and 1985. The main changes are of a localised nature and are related to growth in urban and industrial areas.

One of the first observations made is that between 1981 and 1991, almost all the settlements (represented by a kilometric grid) of the coastal strip were located in areas where the land cover is agricultural (Fig. 35). Among the settlements that were located outside the agricultural areas, one, located in the south of the coastal band disappeared in 1991 as a result of the decrease of its population, and another emerged next to Tróia as a result of the development of a tourist venture.

As mentioned above, this is an area with a low rate of land cover change between 1975 and 1985. The main land cover changes in this coast are recorded in three areas: in the north, next to the estuary of the river Sado; in the centre, next to the area of Sines / Santo André; and in the south, next to the coastal strip limit.

3.3.1. Land Cover Change Related to Urban and Industrial Pressure

The land cover changes observed in the area of Sines and Santo André, basically correspond to the expansion of urban and industrial areas, and are related to strong socio-economic pressures, particularly due to urbanisation and industrialisation. It is obvious that there is no clear spatial overlapping of these dynamics. However, it is important to note that it is in these areas that the two types of dynamics are most intense (Fig. 36).

The relationship between the expansion of industrial areas and the growth of the resident population and the active population in the secondary sector likewise provide some clues that help to understand the relationship between these two types of dynamics (Fig. 37).

This figure shows the variation of the resident population and of the active population in the secondary sector as well as the distance to the areas where expansion of industrial areas was observed. Hence, it can be seen that within a 5-km radius of the areas where there was industrial expansion, there was a general decrease in the resident population (-44%) and in the population working in the secondary sector (-15.2 %) between 1981 and 1991. This decrease was accompanied by the disappearance of six settlements / grids.

Between 5 km and 10 km, there is a buffer manifesting a strong growth of the resident population that almost doubles (91 %), and of the population in the secondary sector (60.3 %). However, this growth is highly concentrated in the city of Santo André and its surrounds, and not uniformly distributed as indicated in the theoretical model. From this area, another 10 km-wide radius is seen to register a new decrease, slighter, in the resident population (-2.6%), and bigger in the active population of the secondary sector (-14.2%). The remaining area manifests a slight increase in the resident population (0.7%), while the active population in the secondary sector sharply drops (-30.9%).

These spatial differences in the evolution of the resident population and active population in the secondary sector reveal a significant difference in dynamism between the two most important urban centres. The city of Santo André and its surrounds have a greater dynamism.

3.3.2. Land Cover Change Associated to Urban and Tourist Pressure

The urban and tourist pressure that is seen in some settlements in the coastal strip identified in the analysis of socio-economic indicators[40] is not related to any type of land cover change in the coastal zone between 1975 and 1985 (Fig. 38). This is due to the fact that these socio-economic changes occurred for the most part, after the last date of land cover analysis. These pressures that are related to the growth of urban areas, reflect changes observed in the 1995 aerial photograph, and on land[41] at present.

[39] Apart from theoretical factors that prevent the establishment of cause and effect relationships between these two dimensions, other factors rendered the cross-referencing of information difficult, such as the time lag between the dates to which the different types of data refer.

[40] Mainly in those that are right next to the coastal line.

[41] While this analysis has not been quantitatively integrated into the study, it is a valuable qualitative contribution to the understanding of the more recent land cover changes.

Socioeconomic information "lugar" and agricultural area

Alentejo Litoral - 1981/91

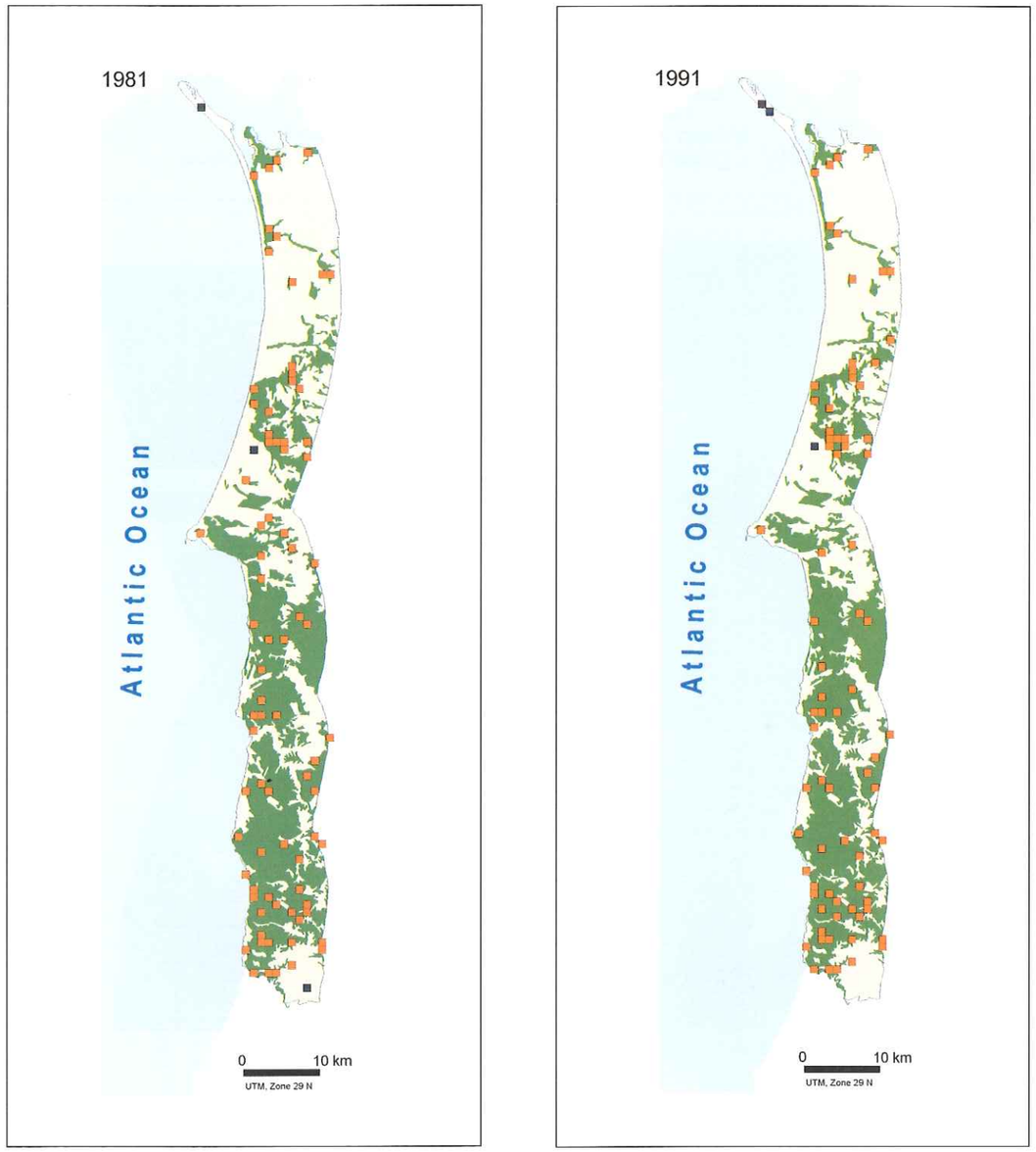


Fig. 35 - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981, 1991; CNIG, CORINE, 1985

Nevertheless, the areas with the greatest tourist pressure are the beaches, lagoon areas (estuary of the rivers Sado and Mira, and the Santo André lagoon), or a rocky coast characterized by very steep slopes. These are areas that should be preserved, given their landscape beauty, the existence of a unique flora and fauna, and the scarcity of human occupation. A natural park in this coastal zone has been demarcated.

Land cover changes 1975-85

Urban and industrial pressures 1981-91

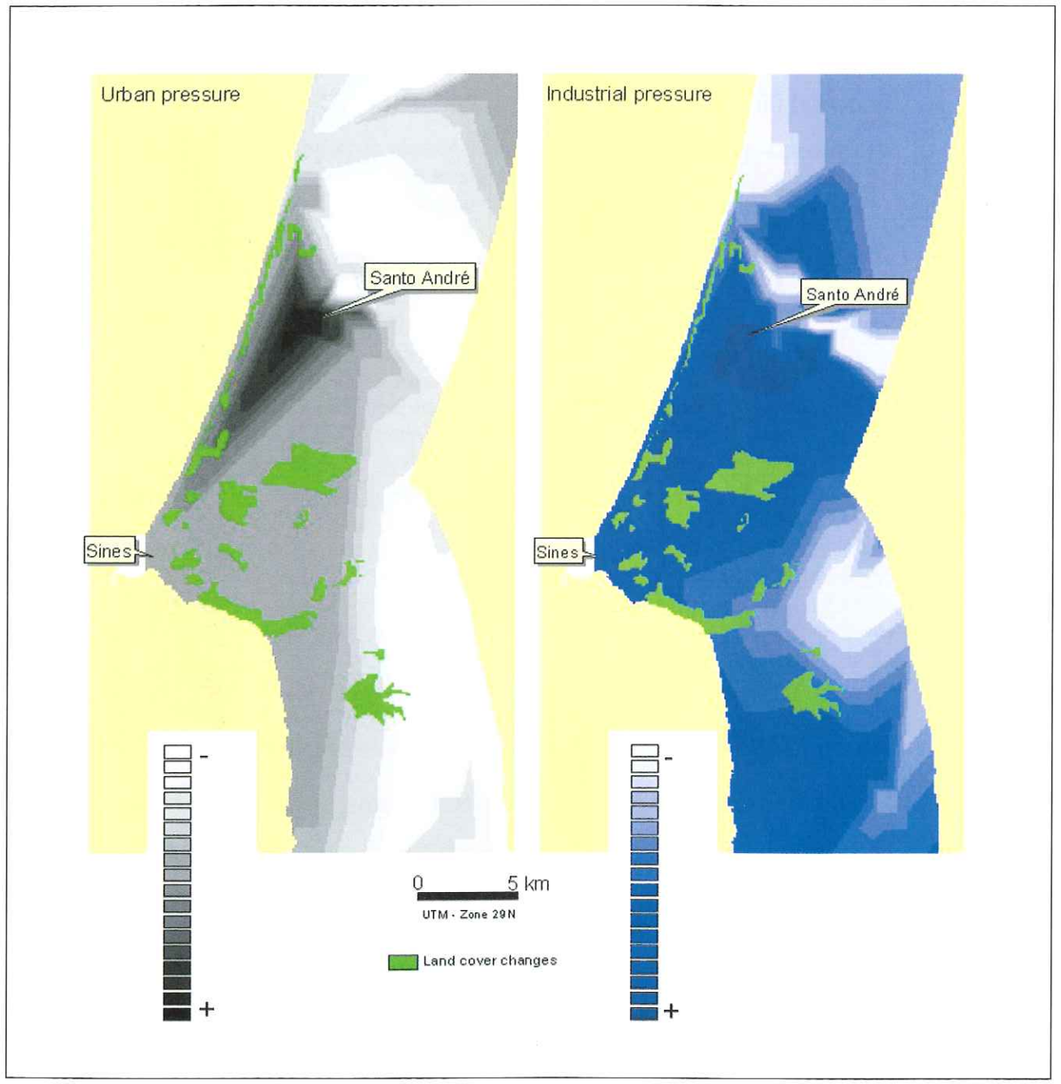


Fig. 36 - Source: INE, XII, XIII Recenseamentos Gerais da Populacão, 1981, 1991; CNIG, LACOAST, 1975; CNIG, CORINE, 1985

Thus, since it is foreseen that the increase of tourist pressure in this coast shall continue places located next to the coastal line, the main land cover changes that will probably occur have to do with the increase in urban areas to the detriment of essentially agricultural areas.

Industrial and harbour areas expantion - 1975/85

resident population - 1981/91

population working in the secondary industry - 1981/91

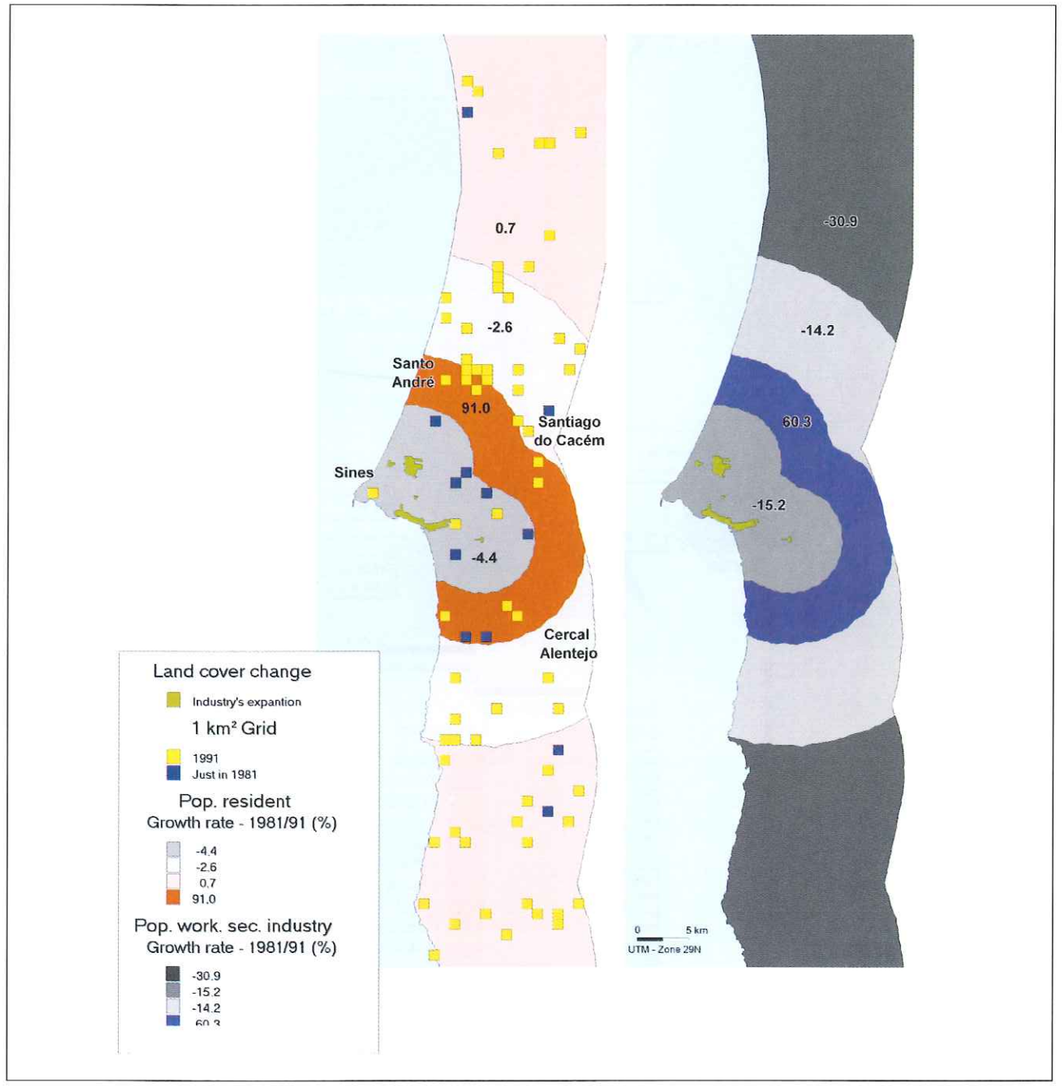


Fig. 37- Source: INE, XII, XIII Recenseamentos Gerais da População, 1981, 1991; CNIG, LACOAST, 1975; CNIG, CORINE, 1985

This scenario corresponds to pressure exerted in this region by various private investment plans that have emerged in recent years aiming to build tourism ventures. Their establishment has however been stopped by fiscal restrictions by various territorial ordinance tools such as the Coastal Fringe Ordinance Plans and the Coastal Alentejo Natural Park Ordinance Plan.

Land cover 1985

Tourism pressure 1981-91

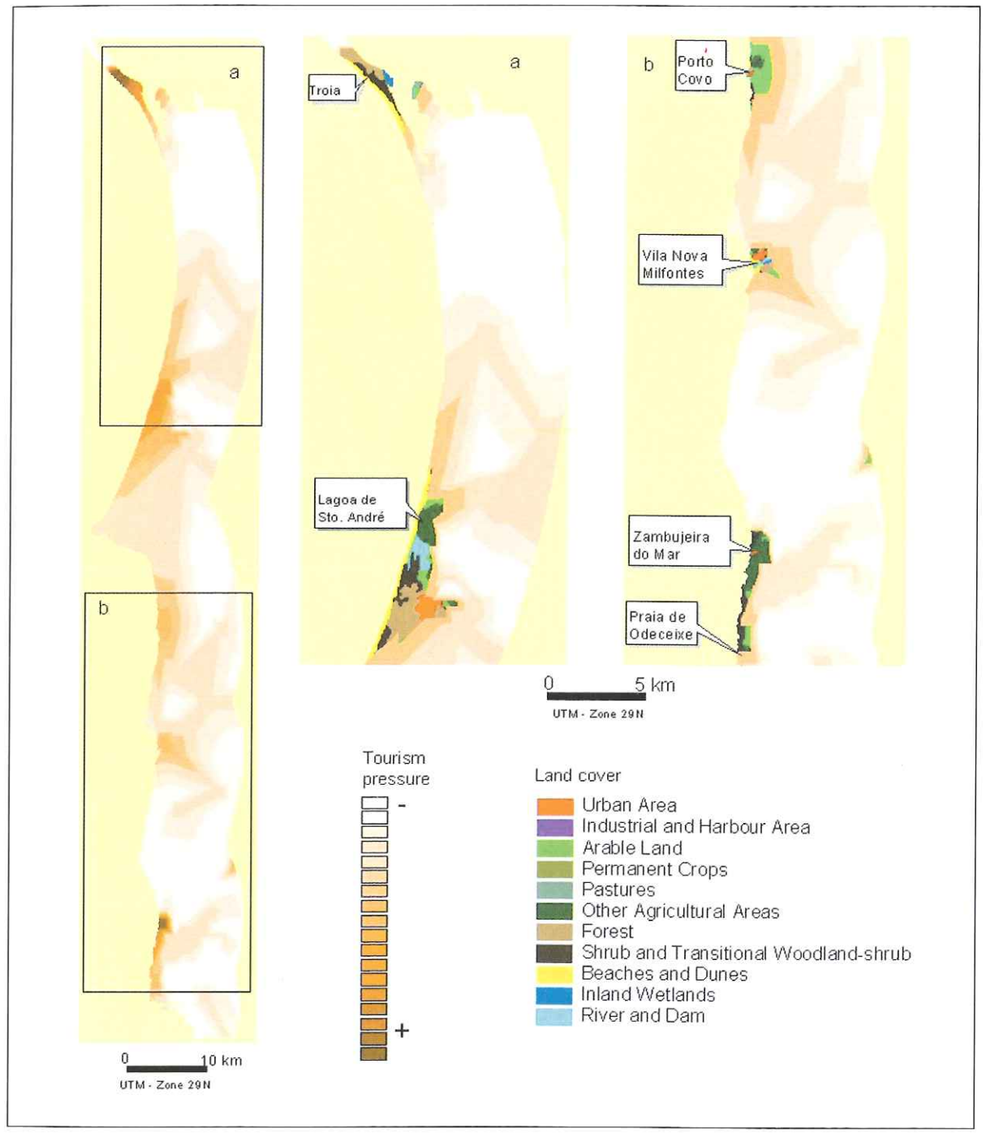


Fig. 38 - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981, 1991; CNIG, LACOAST, 1975; CNIG, CORINE, 1985

Land cover changes 1975-85

Agro-forestry pressure 1981-91

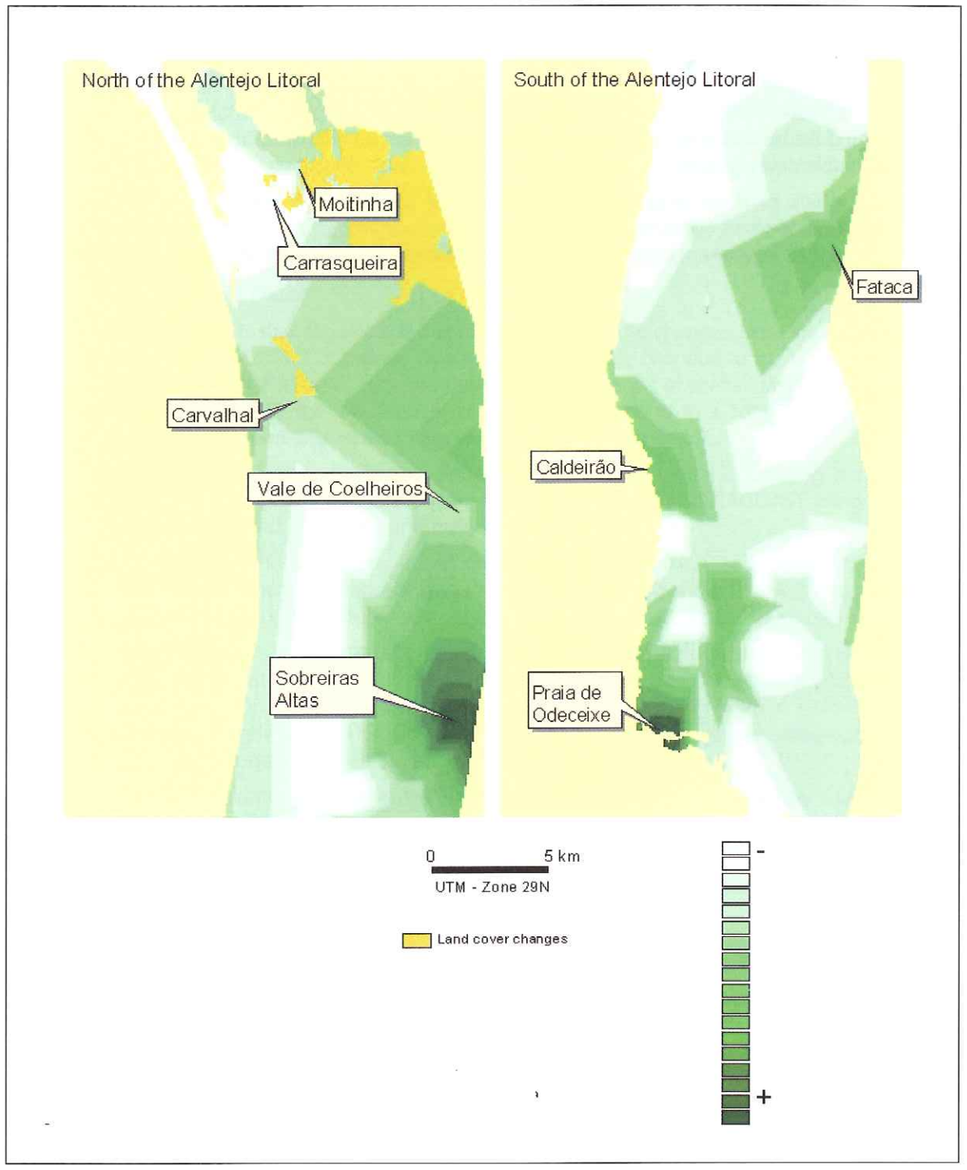


Fig. 39 - Source: INE, XII, XIII Recenseamentos Gerais da População, 1981, 1991; CNIG, LACOAST, 1975; CNIG, CORINE, 1985

3.3.3. Land Cover Change Related to Agro-Forestry Pressure

The areas located in the extreme north and south of the coastal zone have land cover dynamics related to agricultural and forestry use. It is also in these areas that there is the greatest intensity of the socio-economic indicator agro-forestry pressure (Fig. 39).

The analysis of socio-economic dynamics and land cover at the level of the coast explained how the main land cover changes are related to the various socio-economic pressures identified. However, a more detailed analysis and understanding of these processes of change can only be undertaken at the local level of analysis.

At the local level it would be possible to understand, and mainly as far as agricultural land use is concerned, the adequacy of land use strategies regarding biophysical factors such as the slope, the nature of the soils, and the exposure of slopes. In addition, it would be possible to identify the land use projects that were regulated by regional or local policies and the institutional context, making possible in turn an analysis of their degree of efficiency in the process of sustainable development.

Understanding the link of these biophysical factors with the socio-cultural characteristics of individuals, their capacity to manifest in markets (local, regional, national, and supranational) and in land use policies (national and supranational), and their investment capacity, is valuable in understanding the real reasons behind land use change.

4. DISCUSSION

The object of the study, land use and land cover changes in coastal areas, requires the integration of socio-economic and biophysical data. This framework is based on the idea that land cover and land use changes are a result of the interactions between biophysical and socio-economic dynamics. Thus, the methodology can be seen as a tool to assess economic and social dynamics as much as they appear to be factors that limit or promote sustainable development.

The management of coastal areas must be seen in terms of sustainable development. In other words, the problems in these areas go beyond the issue of land cover and land use, but should instead be viewed as a confrontation of different interests and parties, analysing conflicts, competition for use, and development processes.

The main problems that arise in developing a methodology to study nature/society interaction in coastal areas shall be presented in this chapter. Difficulties met in integrating different analysis levels, mainly the individual/local level and the regional level, and their solutions are identified and discussed.

4.1. Critical Review of Data Sources

Availability of Cartographic Data

The cartographic data supports that allowed the identification of land use changes were the CORINE Land Cover database (1985) and LACOAST (1975) database. The study was possible only due to the existence of compatible land use data at these two points in time. These two cartographic supports or spatial data for land use two dates were highly important, particularly the LACOAST project, which correspond to a "downdating" of the CORINE information using the same legend and representing another period of observation.

The effort to harmonise the legend in these two digital maps was fundamental in bringing out the land cover changes. It is important to note the effort in interpretation made in the creation of LACOAST, using satellite images with less resolution than that used in CORINE and making them comparable.

To translate the specificity iof this case study it was created in both LACOAST and CORINE, a fourth level of desegregation of the legend, where the national land use characteristics are shown. Nevertheless, situations exist where there is a lack of adaptation to Portuguese reality, or in terms of specificity of the coastal studies.

The fact that the information is not up-to-date is the most limiting factor for the analysis. The methodology proposed in this study is aimed at understanding the land use changes in the coastal areas. The lack of more recent data prevented the identification of significant changes, since these refer to the period of 1975/85[42]. The analysis of other data sources, particularly the 1991 socio-economic data and the 1995 aerial photographs, revealed that the most intense changes occurred after 1985.

It is important to regularly update the data on land use to identify changes, making a new CORINE a priority. It must allow to cross-reference data with the two previous events of analysis, whether by the original resolution of the image[43], or by greater desegregation of the legend[44].

Other than the limiting factors mentioned above, there were only two land cover periods of analysis, from which it was not possible to detect any fundamental traits of the changes, particularly:

- The cyclical character of the changes: the most typical example of this limitation is the incapacity to identify the phases of the forestry cycle based on two observations. It is a process of change characteristic of the dynamics of *Alentejo Littoral* land use, which can only be analysed in depth with the systemic data on land use over a period of more than 20 years.
- Difficulty in defining tendencies: both observations only identify land cover changes, not knowing whether these correspond to land use changes. The existence of more observations would make possible the understanding of trends in change, thus allowing confirmation of land use changes. The fieldwork would however require a necessary support to understand/identify these land uses, particularly the definition of model cases and the explanation of possible doubts.

[42] Both observations were carried out over a period prior to the entry of Portugal in the EEC. Thus, the impact of this membership to the EEC and changes resulting from the consequent driving forces were not reflected.

[43] The 30m of Landsat TM of 1985 are already outdated.

[44] The need to adapt the legend to Portuguese reality must likewise include the possibility of comparison with other observation events.

Another limitation of the biophysical data available exists in LACOAST. Only a narrow 10 Km fringe of land use from the coastline was identified for 1975. Thereby, the study became limited to this geographical area, which brought up a set of questions on methodology, such as:

- A cut that does not consider the specific traits of this coastal area is artificial.
- It forces the definition of a coastal area without its hinterland, rendering impossible the integration of another level of regional analysis (Coastal Alentejo "The Alentejo" Littoral, NUT III) with land use data.
- It excludes hot spots that may have influence over the coast and that are beyond the 10-km[45] limit.

The availability of 1981 and 1991 cartographic data that supports the alphanumeric data at the level of the kilometric grid, only possible through the study conducted by CNIG, allowed for a more effective comparison of these data with the biophysical information, since the level of desegregation is superior to that of the parish. However, the inexistence of socio-economic data at the level of the kilometric grid for 1970 prevented the comparison of these data in the census prior to LACOAST.

It is likewise important to update the geo-referenced data in the grid for the next census in 2001, so that it would still be possible to analyse the evolution of socio-economic data with a 1- km² detail.

Despite the digitisation in 2001 of the cartographic data in the sub-sections, it is still important to maintain the geo-referenced data in the grid, and this for two reasons. First, there is a need to conduct evolutive analyses at a level of detail superior to that of the parishes; secondly, the digitisation of the sub-sections allows for the simplification of the geo-referencing of the socio-economic information on the kilometric grid.

In terms of the cartographic data of the institutional component, it would be important to make available certain territorial management tools, such as RAN, REN, and the urban and urbanisable perimeters defined in the Municipal Master Plans.

The use of the GIS is essential in the formulation of these kinds of tools, and for their constant updating. Consequently, there is an urgent need to promote the production of digitalised data supports and to facilitate the availability of information in a digital format, which may allow the rapid formulation of these instruments. Without being necessar always to start from zero when the aim is to conduct these kinds of analyses.

4.2. Limits to the Methodology

The difference between the land use and land cover analyses has been the subject of discussion of various scientists working within the framework of the LUCC/IGBP programme. This study rese some questions that may contribute to the enrichment of this discussion.

The identification of the land cover provided some clues in the understanding of land use. However, only when other pluridisciplinary data sources, including statistical data, were analysed, did these clues turn into explanatory hypotheses of land use.

Nevertheless, these hypotheses need confirmation, which is only possible with the understanding of processes of change based on a local analysis, particularly through interviewing privileged actors.

The guiding question of the proposed methodology was the following: What are the ways of refining the methodology in order to obtain results closer to the land use? In an early phase, the analysis introduced new ways of cross-referencing the biophysical variables with alphanumeric data (General Population and Housing Census) in order to reinforce the understanding of land use changes. In a later phase, which was not carried out in this study, it would be useful to carry out fieldwork in order to identify the factors of land use change[46].

GIS was constructed aiming to support the whole methodology of the study. In the creation of this System, it was necessary to analyse big changes in land use, and attempt to understand the processes of change (intensification/ extensification) caused by the socio-economic and institutional factors.

The model proposed for cross-referencing has a pluridisciplinary base and aims to essentially explore the possibilities of changing scales at various levels of a GIS. On the one hand, various spatial levels of analysis are defined, in accordance with the desegregation of the data; on the other hand, a hierarchy of priorities relative to the type of information that needs to integrate each of these spatial levels is it established.

[45] This question was particularly relevant in the study, since the geographical limit of the coastal band excluded four of the five municipalitys of Coastal Alentejo that correspond to important growth poles brought about by the increase in importance of the tertiary sector.

[46] The initial proposal excluded fieldwork, taking into account the period given for the completion of the study.

However, when examining these geographical scales, and thus strengthening the capacity of analysis, it was not yet possible to answer the essential question in understanding land use changes. This is because this study lacks the analysis of the local dimension that provides GIS with the information which truly *socialises* it.

By introducing the level of the kilometric grid to the treatment of socio-economic data, a level of detail essential to the comparative analysis of biophysical and socio-economic factors was added. Nevertheless, this level created a drawback: the notion of urban perimeter was lost, since the original statistical data aggregates the data of bordering places in one central place.

The analysis of the statistical subsection[47] would have kept the notion of perimeter. However, this statistical division has the risk of being overly burdensome, both in terms of costs related to data acquisition, and in terms of unnecessary detail at the regional level of analysis. The data disaggregated to the statistical subsection would only be justified at the level of local analysis.

4.3. Analysis at the Individual Level

It is only possible to understand the main trends in change when the spatial context is placed on a regional scale. However, the main references for the analysis of intervening agents at this scale, reflected by land use changes and allowing the understanding of the decision making processes, are lost.

One of the central characteristic of the integrated methodology corresponds to the necessity to link different spatial levels of analysis. It is from this type of linkage that we can understand how biophysical and social drivers interact.

Given that individuals are main agents of territorial transformation, being responsible for some of the biggest changes registered in the landscape, it becomes fundamental to understand the way in which they intervene at the local level.

In fact, it is at the local and/or individual level that the main factors influencing the decision-making processes in terms of change can be understood. It is at this level of analysis that the linkage of biophysical and social drivers becomes essential to the understanding of the identified land use changes.

It is possible at this level to understand the real influence of natural factors, such as the slope, the existence of water or the quality of land, in the decision to maintain or to change a particular agricultural or forestry land use. On the other hand, decisions are also influenced by socio-economic factors, such as the capacity to link with the market, the facility of access to information and decision-making means, the level of instruction of the agents or their reasons for investing. These can only be understood at the local and/or individual level of analysis.

At the local level, we can understand in depth the relation between natural and social factors. However, these factors can also be integrated at the regional level. In reality, the nature/society relation that is observed at the regional level allows us to understand, in part, the identified options in land use. Nevertheless, this knowledge is limited by the level of regional analysis and by the detail of the information obtained at this level. Thus, only the integration of different factors at a local level allows for an in-depth knowledge on the land use change.

The economically-peripheral situation of the *Alentejo Litoral*, as well as its systems of agricultural and agro-forestry production are a result of the interlinks among environmental conditions of the region (climatic conditions with a tendency for drought, plain relief, water shortage, poor soil), the geographical position of this region next to the sea, the distance in relation to the main access routes, and planning options taken in the 70s.

However, analysis of this linkage at the regional level, does not allow the understanding of underlying factors of land use, or the occasional cases of intensive and irrigated agriculture, of forestry for industrial purposes, of growing urban and tourist centres, and industrial growth poles. It is possible to investigate and to understand the factors that limit the activity of individual authorities by these dynamics at the local level. The methodology helps us become aware of and understand the factors and processes of land use at different levels of analysis. At the regional level, the main constraints from the biophysical and socio-economic points of view are registered. At the local/individual level, it is possible to understand the reaction of individual agents of transformation to those constraints.

In summary, in order to reach these type of conclusions about land use, it is fundamental to proceed with the collection of data on the main social actors: farmers, businessmen, municipal authorities, etc. At this stage of analysis, the GIS must also serve to select the areas to be studied in more detail, the structure of interviews, since it allows us to set questions that are more adapted to the needs of the study and at the level of data treatment and integration.

[47] The statistical subsection corresponds to the maximum unit of spatial disaggregation of the data. The Population Census of 2001 will consider the digitisation

Going through the different spatial levels of analysis, we can pass from the analysis of land cover changes identified in the coastal zone of the Alentejo, to an understanding of the underlying factors of land use change processes, only entirely possible after an analysis at the local/individual level.

The extrapolation of these local processes to more vast areas must be conducted with great care. Due to the representativity of these chosen areas, it may be possible to extend the conclusions to the coastal area of the Alentejo. However, it becomes risky, if not impossible to extrapolate these results to the hinterland or to other coastal areas.

CONCLUSION

The fundamental objective of this study, ''Land use change: A Methodological Approach to Understanding the Nature/Society Interactions in Coastal Areas", was the development of an integrated methodology for analysing land use changes in coastal areas.

The difficulties in the development of this methodological approach were presented in the previous chapter. However, the main limitation to the development of this methodology arose from the short period of time (approximately eight months) in which this study was carried out and which prevented to do a field work for the various agents of change in the studied region so the phase relative to the analysis at the local/individual was not carried out.

Nevertheless, this level of analysis remains extremely important to the understanding of land use changes, given that it is at this level that the influence of the various agents of change present in the region are expressed, whether of a biophysical (climate, soil, landforms, vegetation), socio-economic, or institutional nature. It is from this phase that the various land use strategies result, being possible at this level to know and to understand the reasons for changes or hot in land use.

The study of land use changes (in coastal or non-coastal areas) thus appears to be an essential contributing factor to the understanding of Global Change. In fact, while the problems that these changes cause are diverse, they have one aspect in common: they can risk the sustainable development of a region at.

Thus, in developing countries that have high population growth rates, there is a need to increase and to intensify agricultural production, in competition with urban and industrial use of the territory, causing serious problems in terms of deforestation and soil degradation (by erosion and pollution).

On the other hand, in industrialised countries (and in Europe, in particular) where there are low population growth rates, the problems resulting from land use changes have a different nature. The tendency in the European Union for agricultural areas to decrease, brought about by the Common Agricultural Policy, has been accompanied by the expansion of land use stimulated by urban growth and tourist activities. In certain regions, this type of land use has had a very rapid growth, and without thorough territorial planning, has contributed to the degradation of natural resources and the landscape, putting at risk the economic development model itself.

In this sense, it is fundamental to measuring, monitoring, and managing land use changes in such a way that the use of the territory is balanced and does not create negative impact on the landscape and natural resources. The methodology developed attempts to contribute toward this objective (Fig 40).

The diagram that follows schematically illustrate the methodology developed in this study, the theoretical framework of expression of biophysical and socio-economic data at different levels of analysis.

Despite the difficulties related to the availability and temporal harmonisation of the various aforementioned data sources used, this methodology constitutes an important effort to operationalise the various phases necessary for the study of land use changes.

The diagram thus reflects the methodology for Measuring, Monitoring and Managing Land use / Land cover Changes. The way in which it is presented illustrates the architecture the various phases of operationalisation of the research must be set.

In an initial phase, the patterns and land cover changes, as well as the socio-economic dynamics are identified at the regional level, which in the case of this study is the Alentejo coastal strip.

The integrated study of biophysical and socio-economic data conducted at various levels of spatial analysis was developed by using a tool of fundamental importance, the Geographic Information System. Recurrent throughout the research project, this type of integrated analysis, permitted in this phase of regional analysis, the identification of the main driving forces and hot spots, the latter being defined as areas where the greatest land use changes are observed or where their occurrence is predictable, thus contributing to the understanding of the processes of land cover change.

Nevertheless, land use changes can only be understood in depth through the understanding of the decision-making processes of the various agents of change present in a given territory. In such a way, the following phase of analysis unfolds at the local or individual level and attempts to find out how people make decisions. As such, the GIS is once again a fundamental tool in the expression and association of a large amount of biophysical and socio-economic data collected at the local level or from the various agents of change.

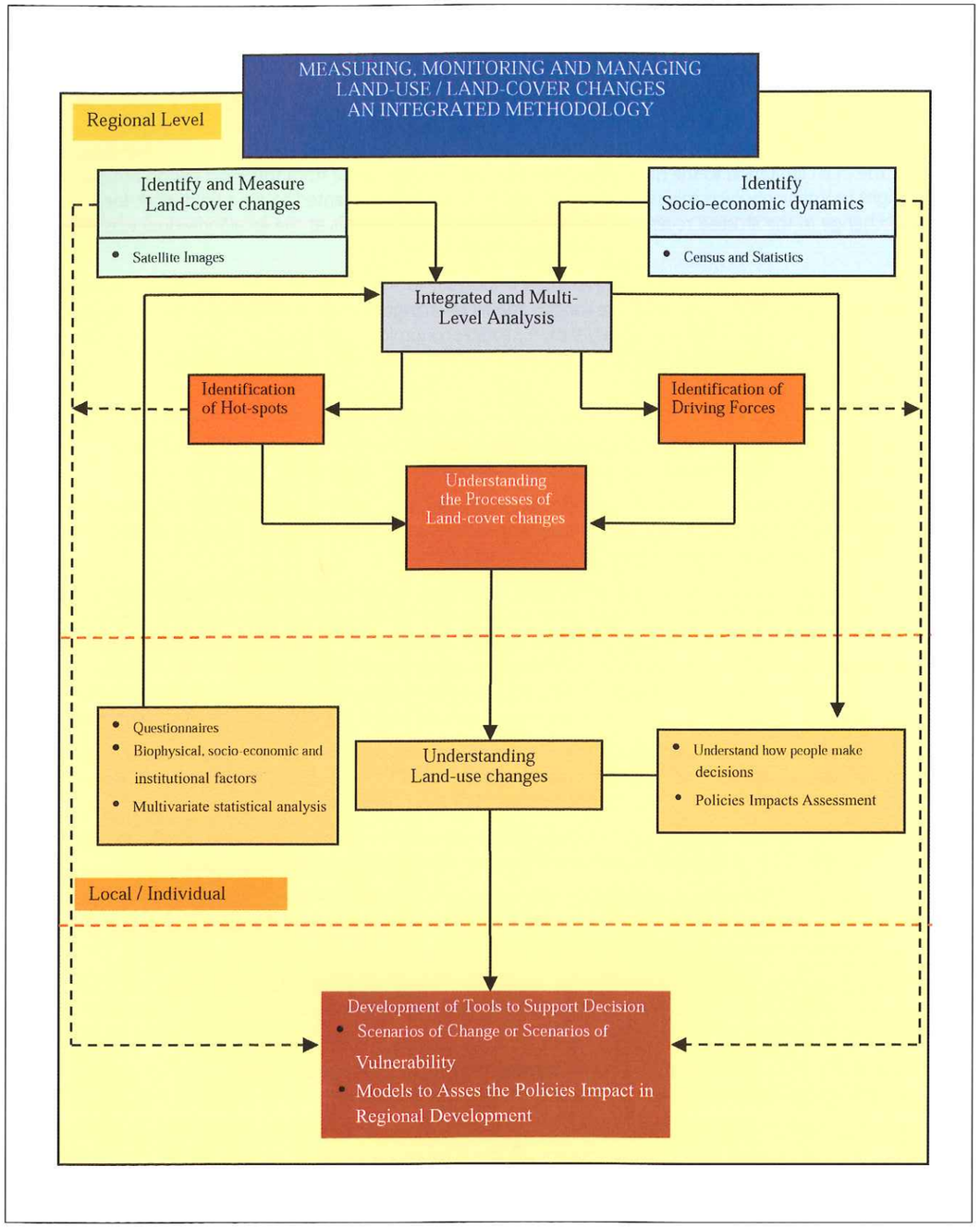


Fig. 40 – Methodology diagram

In this manner, the GIS has shown to be a powerful tool not only because it allows for the integration of large amounts of data of different nature (biophysical, socio-economic, and institutional), but also for the survey of various levels of analysis, thus supporting integrated analyses. As mentioned above, the relation between land cover and land use and the socio-economic data are rarely direct. Nevertheless, the association of these types of data is crucial to a methodology of study of land use changes, as it allows us to make a first reading supported by the processes of change at a given regional scale. The socialisation of the GIS, however, is only fully developed with the creation of a local level of analysis, where it may serve as support for structuring enquiries for agents of change, thereby putting forward more detailed and founded explanations of land use changes.

It is in this phase of local / individual analysis that we may understand the way in which people adapt their land use strategies to the biophysical framework and to the institutional framework, thus contributing to the measurement of the real impact of national or European planning and ordinance policies.

This is a methodology that is useful for the various agents of change in that it contributes to the construction of tools to support the decision-making process. Thus, in a regional context such as the European Union, where strong pressures that lead to accelerated changes are registered, and where these in turn demand adequate and likewise rapid answers, we can see the need for this type of tool that supports the decision-making processes at the national, regional, and local level, and even at the level of individual decisions.

Hence, the usefulness of this methodology lies in the construction of scenarios of change or vulnerability, by attempting to identify the critical areas of land use change (present or future), and understanding and evaluating the vulnerabilities of those areas relative to those changes.

In addition to this, it becomes possible to construct models from the methodology developed for the evaluation of the impacts of national and supranational policies, thereby contributing to the evaluation of the real effects of these policies on land use change and the balanced occupation of the territory, or in other words, on the sustainable development of a region.

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ANNEXES

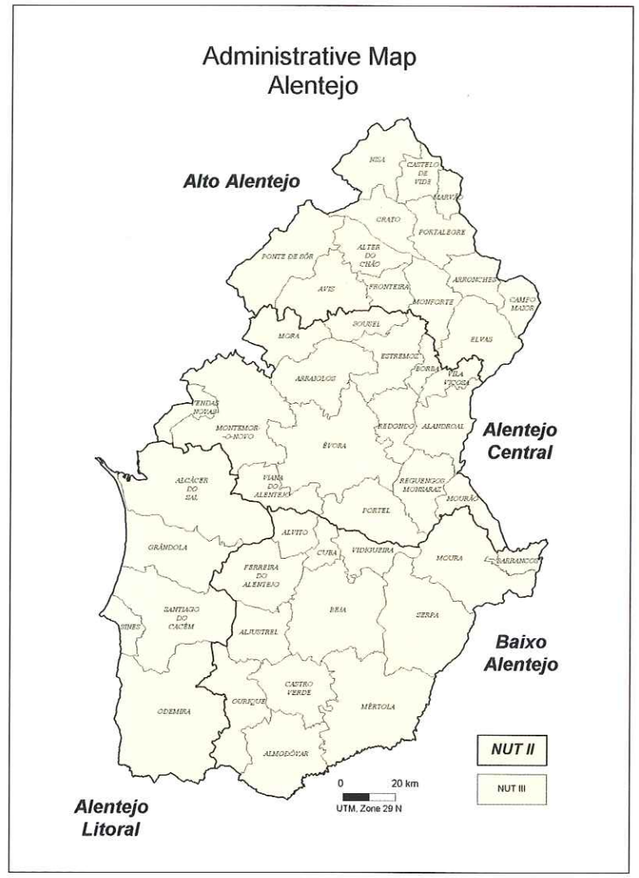
Annex 1 – Administrative map, Alentejo (NUT III)

Annex 2 – Administrative map, Alentejo Litoral (NUT II)

Annex 3 – Administrative map, Coastal Band

ANNEXE 1

Municipalities	Area_km²
Almodôvar	785
Alvito	270
Barrancos	165
Beja	1,138
Castro Verde	573
Cuba	168
Ferreira do Alentejo	651
Mértola	1,289
Moura	965
Odemira	1,722
Ourique	663
Serpa	1,106
Vidigueira	322
Alandroal	536
Arraiolos	682
Évora	1,306
Montemor-o-Novo	1,222
Mora	445
Mourão	286
Portel	609
Redondo	364
Reguengos Monsaraz	459
Vendas Novas	214
Viana do Alentejo	388
Alter do Chão	359
Arronches	320
Avis	603
Campo Maior	242
Castelo de Vide	260
Crato	402
Elvas	626
Fronteira	249
Marvão	148
Monforte	423
Nisa	574
Ponte de Sôr	846
Portalegre	444
Sousel	275
Alcácer do Sal	1,442
Grandola	812
Santiago do Cacém	1,080
Sines	189
Estremoz	515
Borba	145
Vila Viçosa	199
Aljustrel	462



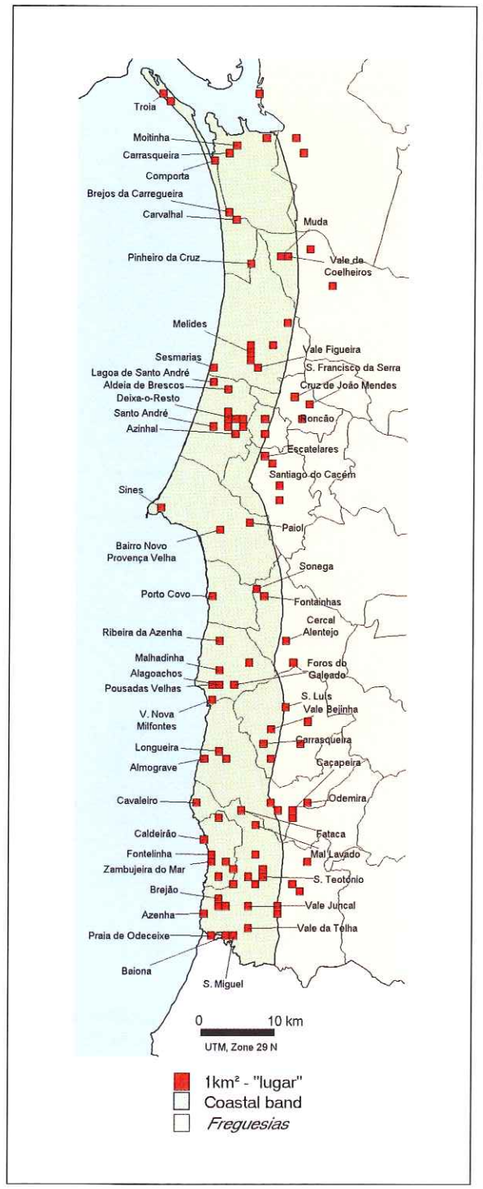
ANNEXE 2

freguesia	Area_km²
BICOS	56
SANTIAGO	280
AZINH BARROS E S. MAMEDE SADAO	162
PEREIRAS-GARE	67
SANTA CLARA-A-VELHA	99
VALE SANTIAGO	62
SANTA SUSANA	172
ALVALADE	164
SAO MARTINHO DAS AMOREIRAS	144
ERMIDAS-SADO	88
TORRAO	352
SANTIAGO DO CACEM	119
SANTA MARGARIDA DA SERRA	49
SABOIA	153
SAO MARTINHO	86
ZAMBUJEIRA DO MAR	41
CARVALHAL	56
CERCAL	140
SANTA MARIA	83
SAO DOMINGOS	204
RELIQUIAS	117
SANTA MARIA DO CASTELO	427
SAO BARTOLOMEU DA SERRA	63
COLOS	104
LUZIANES-GARE	101
ABELA	141
GRANDOLA	382
COMPORTA	115
SAO SALVADOR	167
SAO LUIS	152
VILA NOVA DE MILFONTES	79
SAO TEOTONIO	306
PORTO COVO	49
SINES	144
SANTO ANDRE	90
SAO FRANCISCO DA SERRA	52
MELIDES	167
SANTA CRUZ	26

ANNEXE 3

Localization map

Coastal strip - 1991



Source: INE, Recenseamento Geral da Populacão, 1991; CNIG, Indicadores socioeconómicos derivados dos censos

European Commission

**EUR 19592 – Land Use Change:
Methodological Approach to Understand the Interactions
Nature / Society in Coastal Areas
(Alencoast)
Final Report**

Nelson Lourenço, Maria do Rosário Jorge, Carlos Russo Machado, Luís Rodrigues

1999 – 116 pp. – 21.0 x 29.7 cm

The aim of this project was to design a methodology that allows the understanding of land use changes in coastal areas, and this, through an analysis of the impact of human and biophysical dynamics. The cross between human and biophysical factors, which is at the root of land use, contributes to the understanding of the complexity of processes of change.

The analysis of the processes of change in coastal areas and their relation with external driving forces, such as policies, was made possible only by considering regional dynamics.

The research project was based on a cross-disciplinary approach to understanding change in coastal areas, integrating both socio-economic and biophysical dimensions. The study examines societal driving forces – political, economic, institutional and social - that influence the development of coastal areas and modify the landscape by changing landforms, land use and land cover.

The methodology is designed to analyse the problem progressively by levels – national, regional and local. One of the main challenges was to combine information from different sources and of different nature and scales into the system of analysis.